

ETAAC Advisory Committee

Local Implications of Climate Change

Susan Hackwood

California Council on Science and Technology

May 31, 2007

About CCST

- Nonpartisan, not-for-profit corporation established in 1988 by state legislation
- Offers independent expert advice to state government and recommends solutions to S&T related policy issues -- teamed with the National Academies, modeled after NRC
- **Sustaining institutions:** University of California, California State University, California Community Colleges, Stanford University, University of Southern California, California Institute of Technology
- **Affiliate members:** Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory/California, Stanford Linear Accelerator Center, NASA Ames, Jet Propulsion Laboratory
- Work funded by state agencies, foundations, industry
- 14 Board members, 30 Council members, 122 Fellows, 12 Cal TAC

6 Nobel Laureates, 81 National Academies members, 12 National Medals of Science or Technology, 12 science and math teachers

CCST's Energy Agenda

- Deliberation on CA's energy future, joint meetings with NAE and NAS
- **Goals:**
 - Future of sustainable energy options at national & state level
 - Challenges and opportunities in production, distribution, and use of clean, reliable energy sources, including nuclear energy
 - Connect to federal initiatives
 - Create mechanism to inform state policymakers on new and emerging options

Opportune moment: widespread mandate for climate change has government looking for information on options

Social Science and Climate Change Strategies

- 1. We will need to prepare for the challenges of climate change – but what do we need to do and how prepared are we to change?**
- 2. What are the costs of effective behavioral change campaigns using knowledge of successful efforts, e.g., changing behaviors related to smoking, seat belts, and recycling?**
- 3. Once the public is convinced and prepared to change behavior, do we have the ability (technologically and structurally) to offer solutions?**

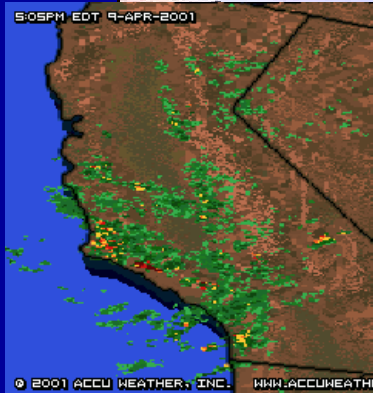
Microclimate Change

**Using the Immense Resources in CA
Asses the Impacts of Climate Change**

**100Km >10K
100 years >10 years**

“Investment Timeframes”

- Think globally,
- Assess regionally,
- Act locally



*Assessing the impacts
of climate change in
California*

California Climate Assessment

Think globally, assess regionally, act locally

- How Assessments have been influential
- The 2007 IPCC Global Climate Assessment
- Why California needs to do its own
- California's first assessment: "Our Changing Climate"
- What improvements are needed?
- Who cares?
- Assess, then assist
- Ways to improve California's assessments
- California has the technical and institutional resources
- Next steps

Policy Assessments

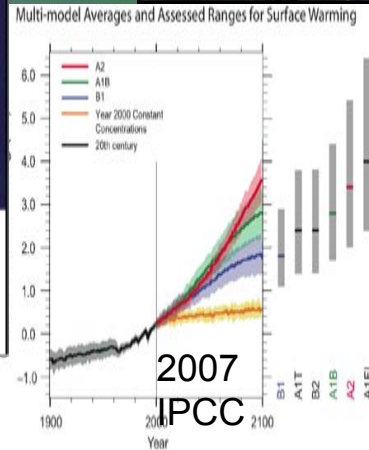
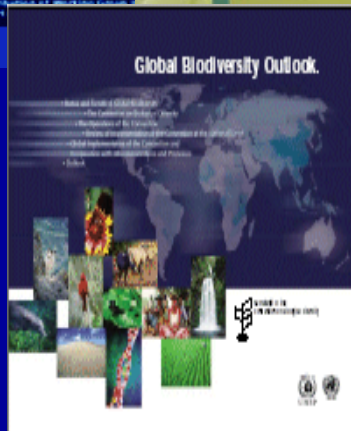
Expert reviews of the state of knowledge

CLIMATE CHANGE 2001
Impacts, Adaptation and Vulnerability



Millennium Ecosystem Assessment

Ecosystems
and Human
Well-being



Global

*High-level
decision
makers*



Regional



California's Climate Action Team

Climate change now a broad governmental concern



Cal/EPA



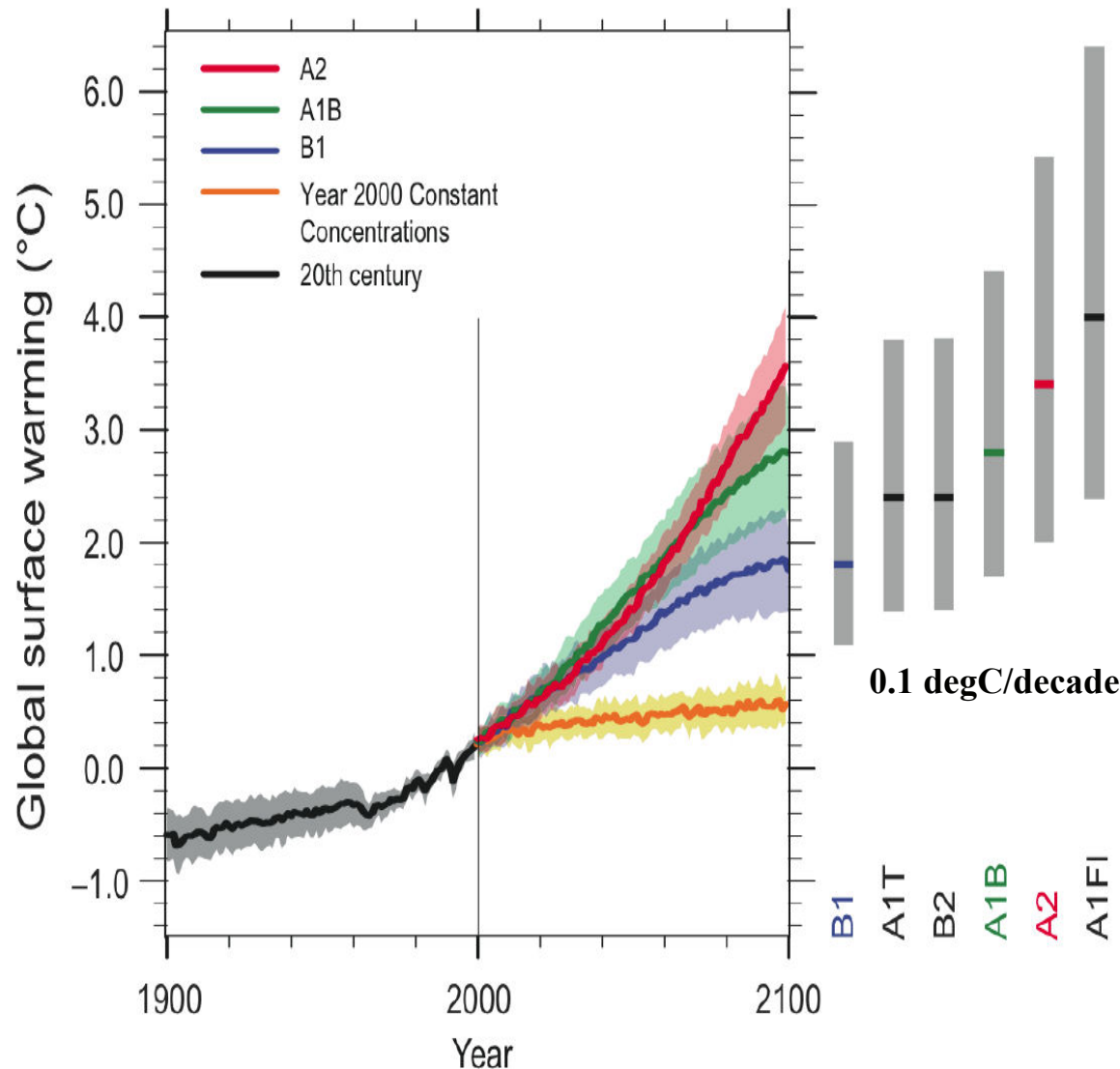
- **Waste Management Board**
- **Air Resources Board**
- **Transportation & Housing**

- **Public Utilities Commission**
- **Energy Commission**
- **Resources Agency**
- **Department of Food & Agriculture**

IPCC Summary for Policymakers, 2007

More climate change is unavoidable

Multi-model Averages and Assessed Ranges for Surface Warming

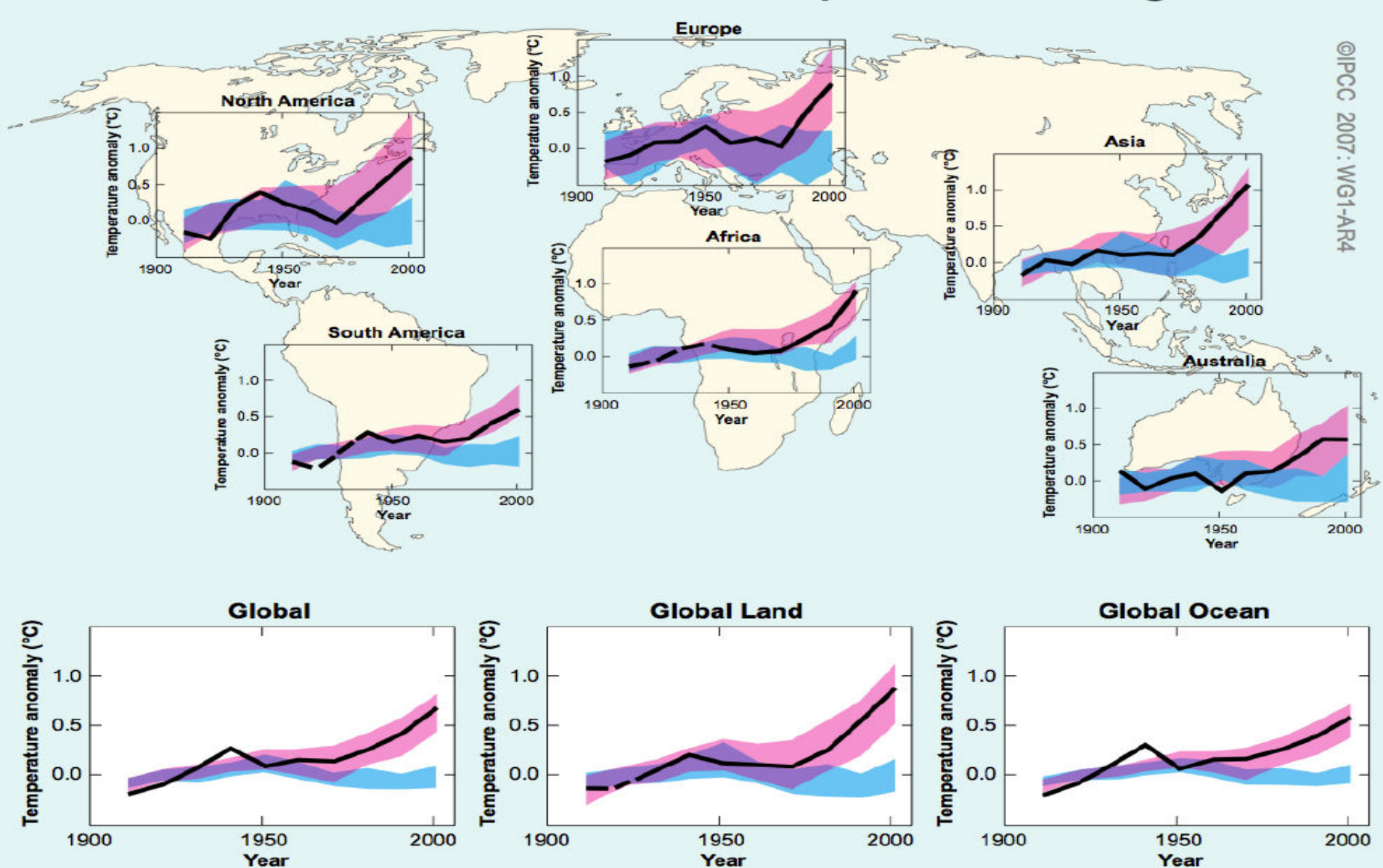


Even if
concentrations
of greenhouse
gases and
aerosols were
held constant
at 2000 levels,
warming
would continue
for a
millennium

Human caused climate warming found on every continent

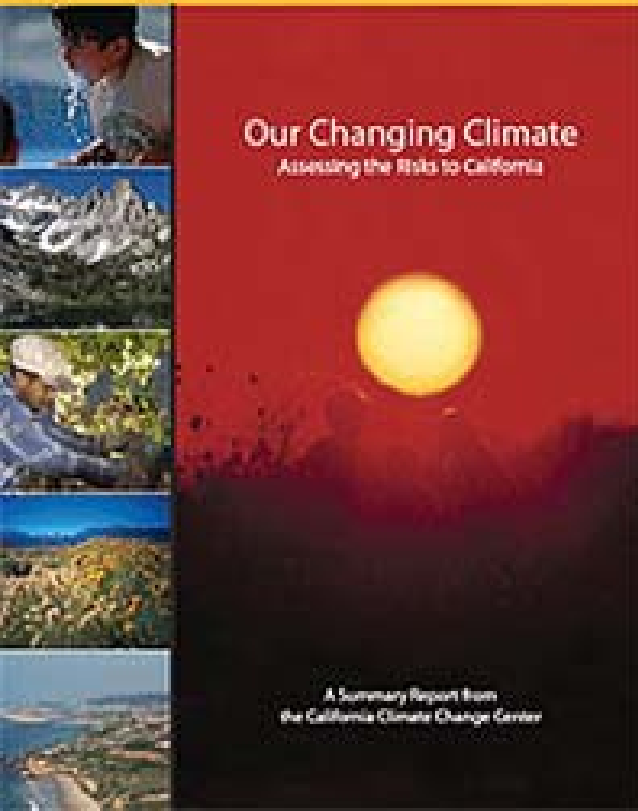
Drying of North American West a robust forecast (IPCC 2007)

Global and Continental Temperature Change

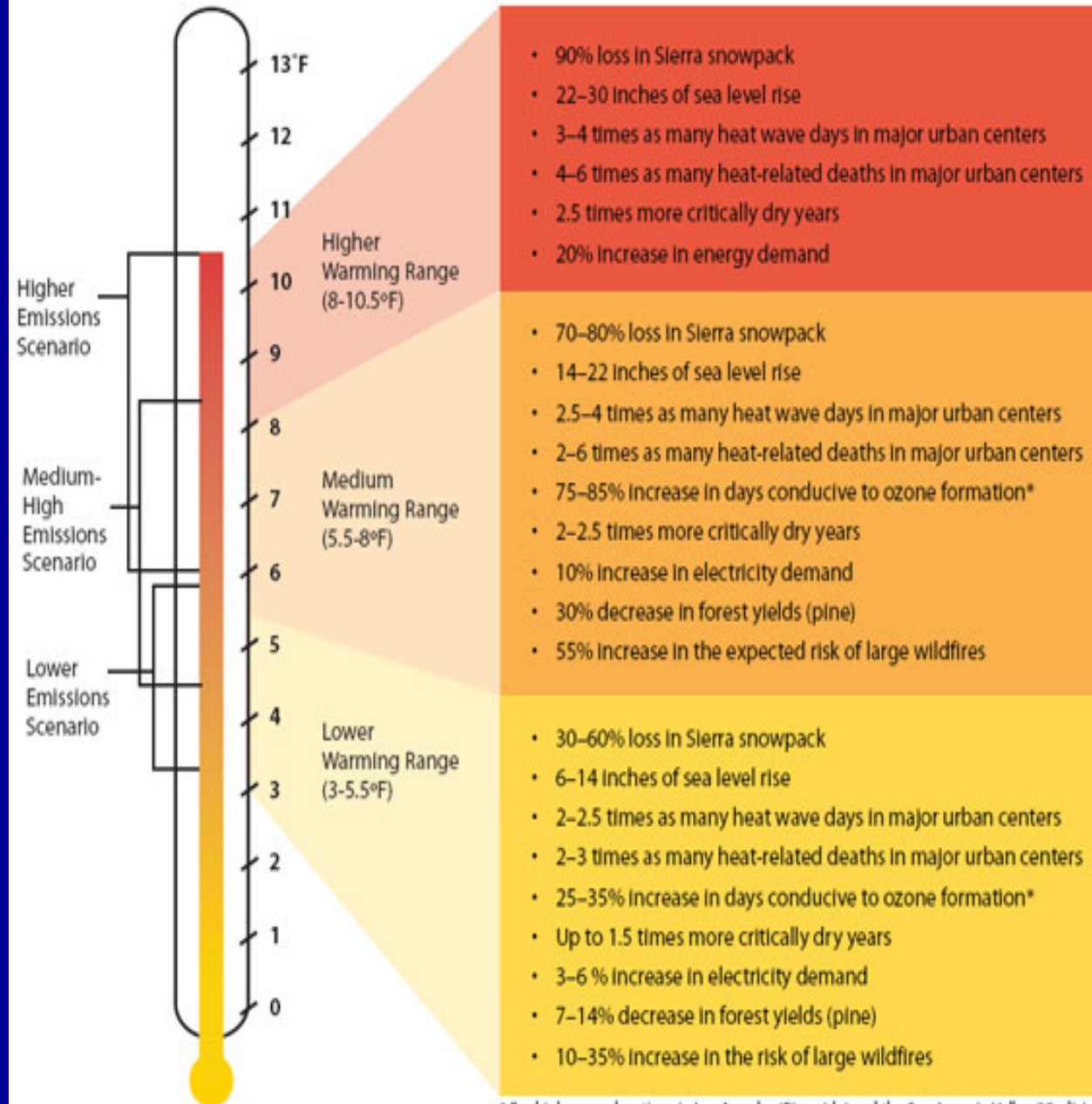


Our Changing Climate

California Climate Change Center



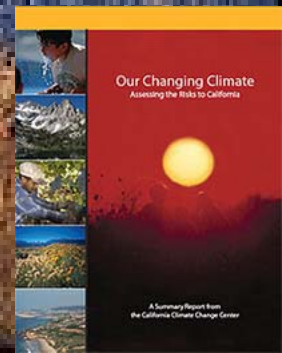
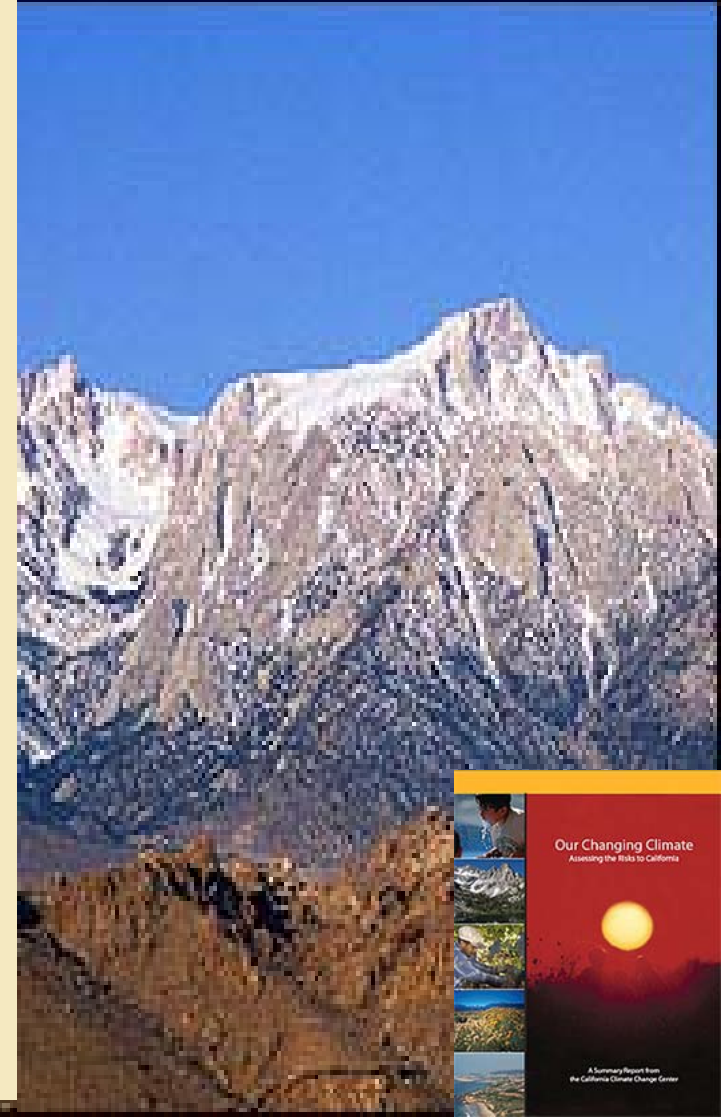
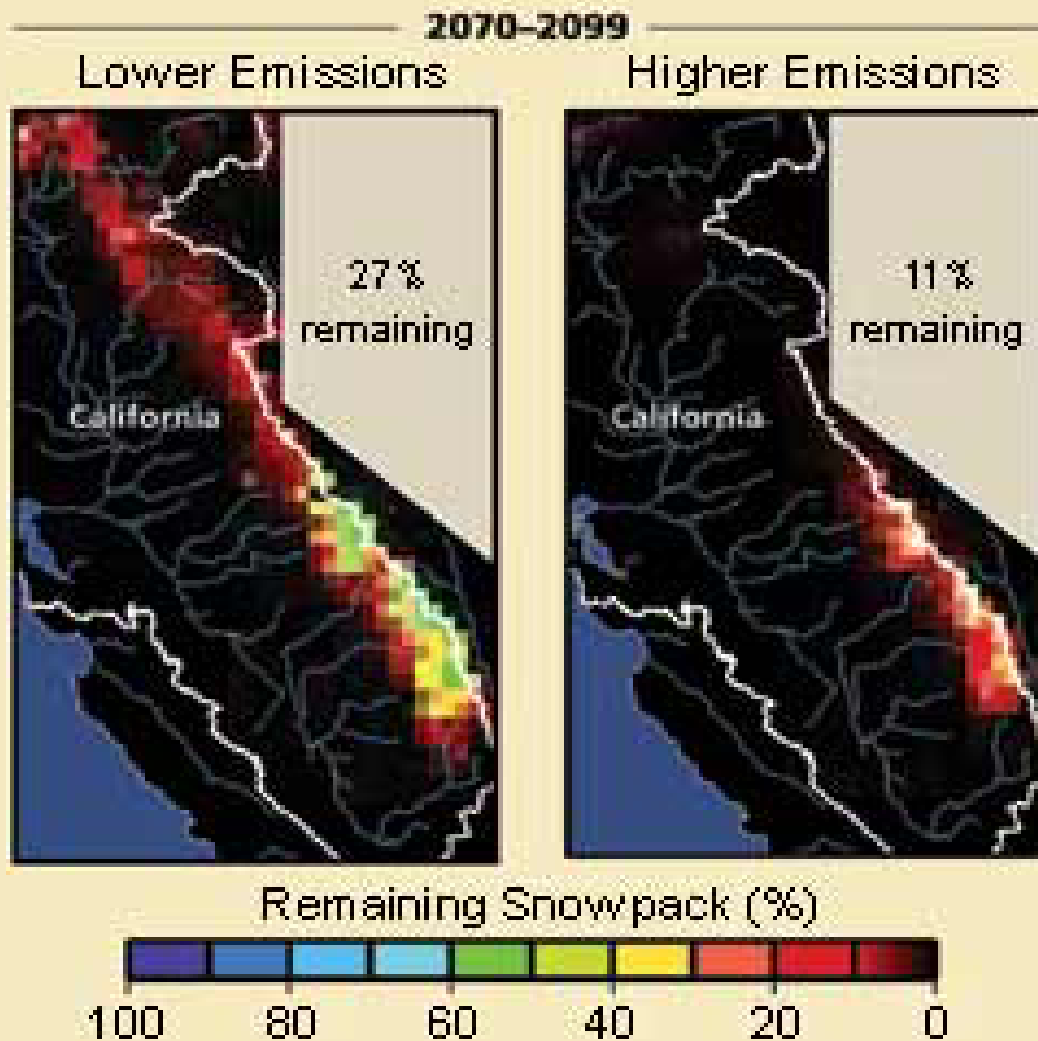
Summary of Projected Global Warming Impact, 2070–2099 (as compared with 1961–1990)



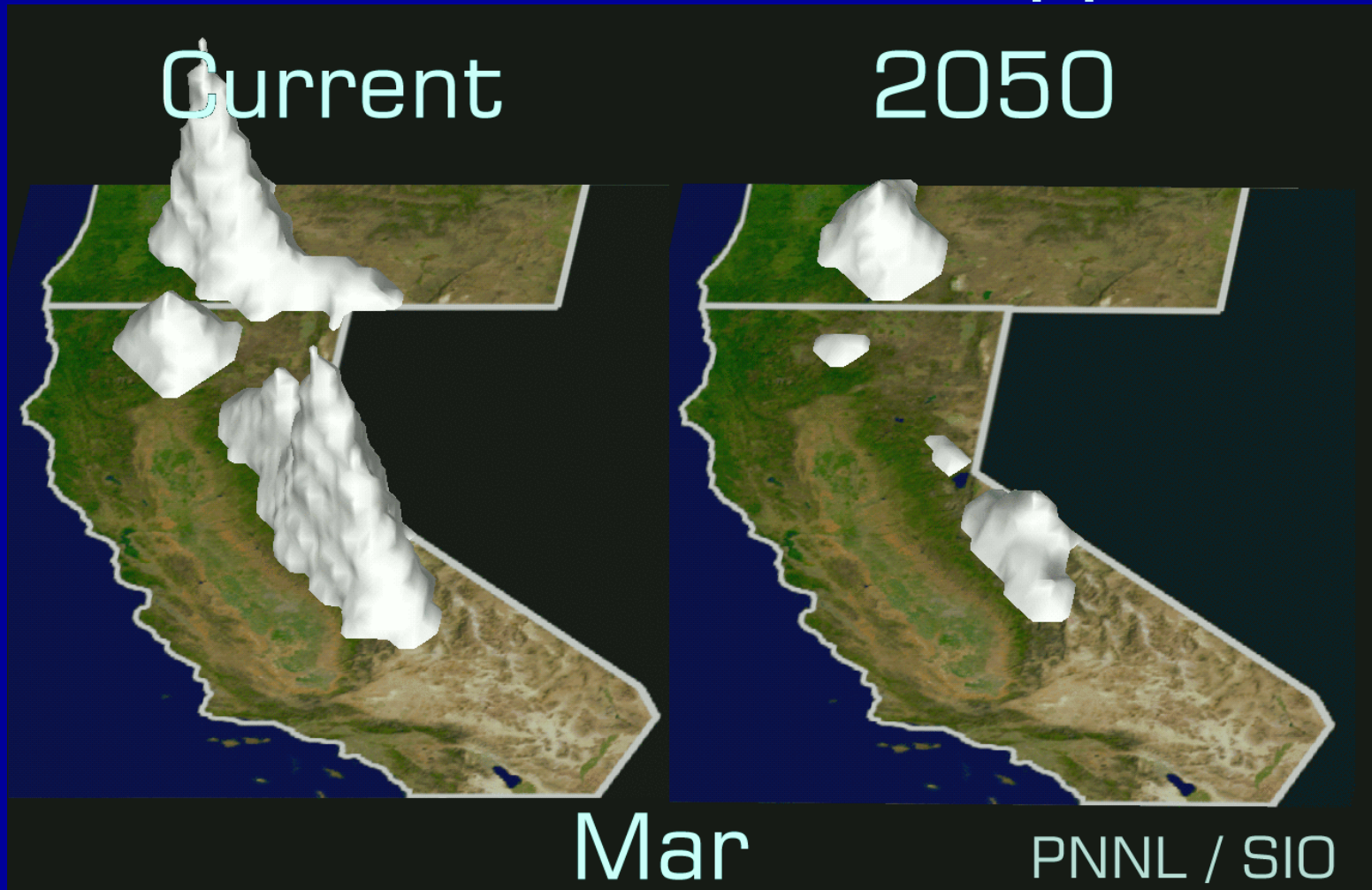


Sierra Nevada Snow-pack

*Stores more water than the
California water project*



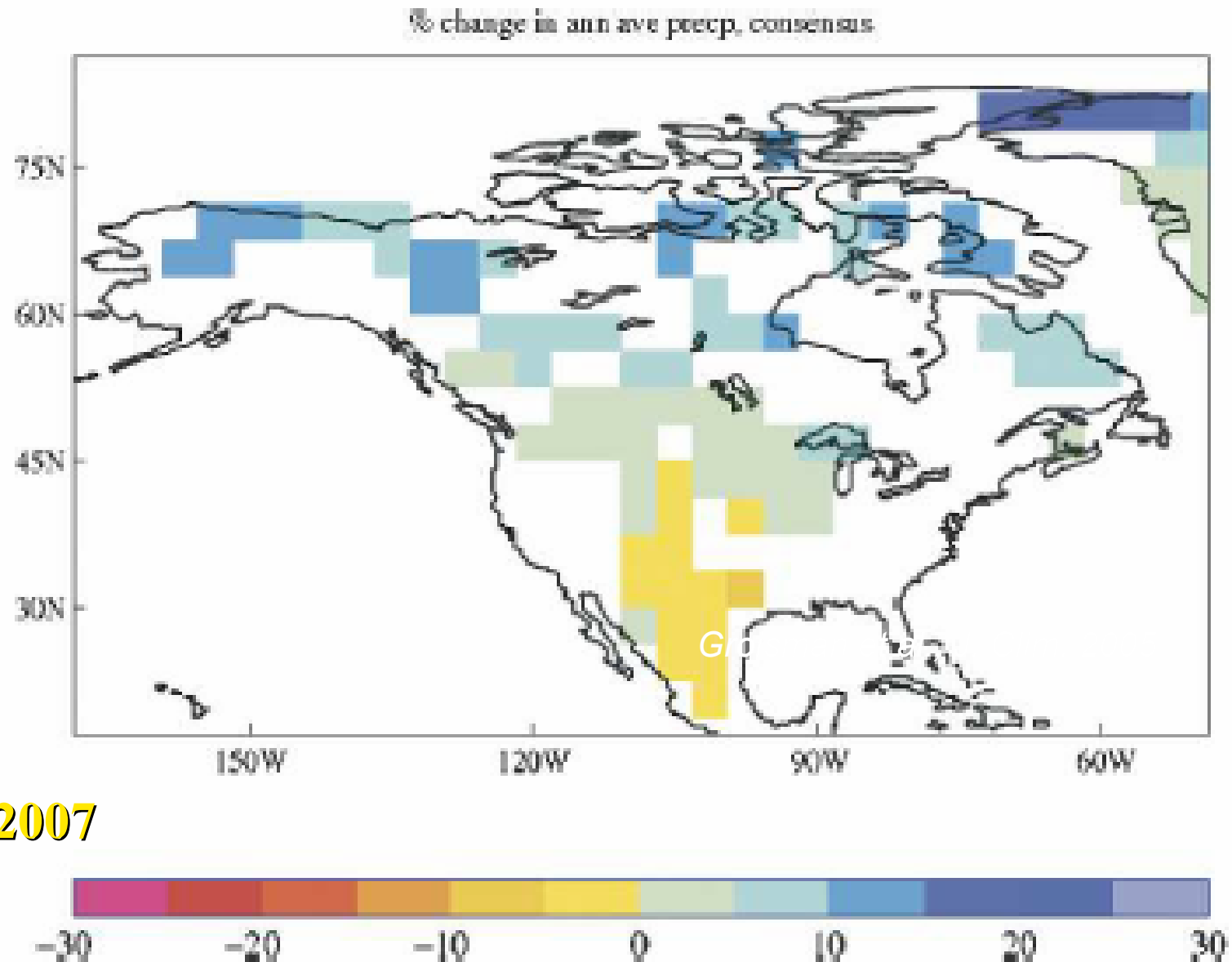
Diminished mountain snow pack will reduce water supplies



Impacts residential, commercial, agriculture, and energy production

Up to 2.5 times as many critically dry years

Whether, where, when to allocate, invest?



IPCC 2007

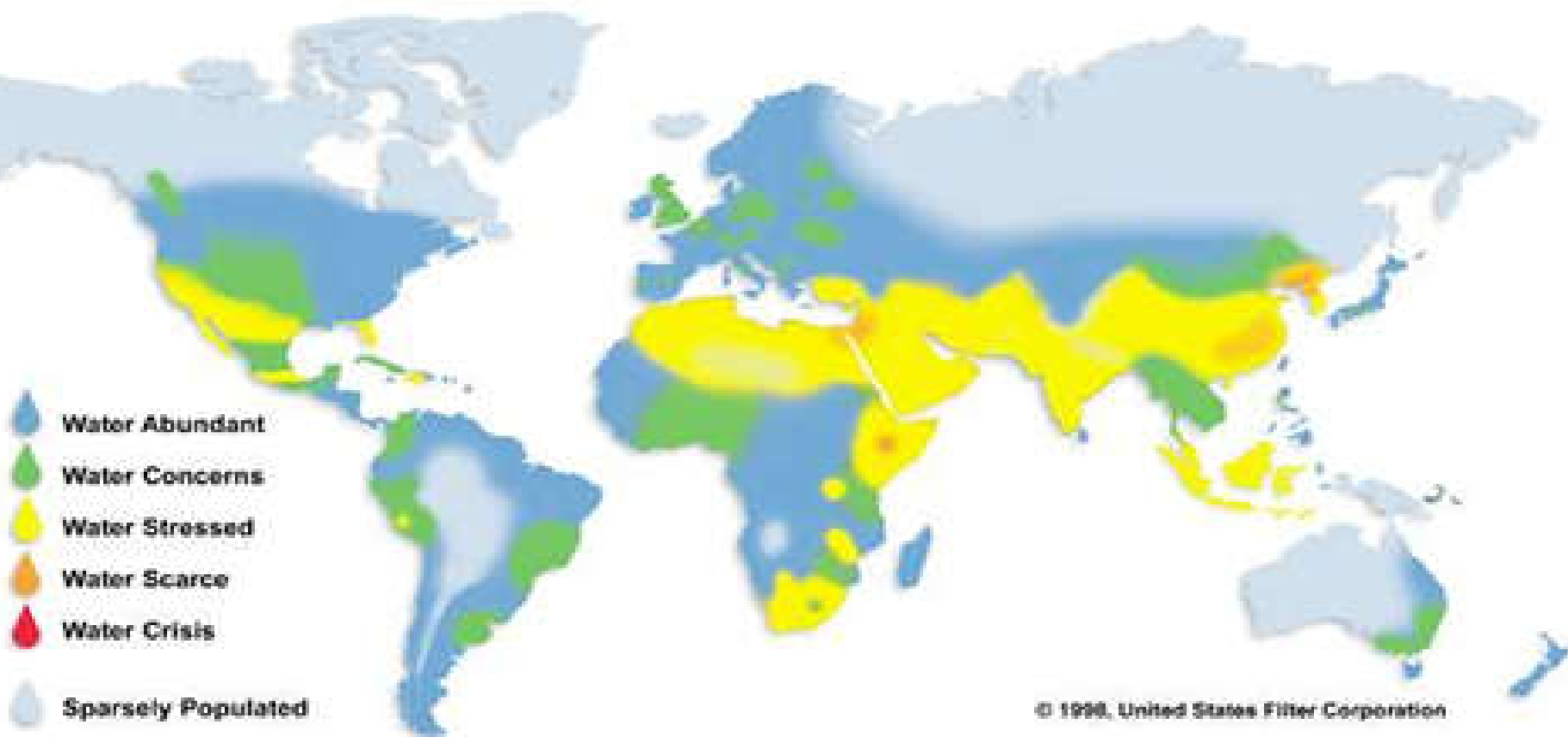


Up to 2.5 times as many critically dry years



Whether, where, when to allocate, invest?

Worldwide Fresh Water Availability Today





Heat Waves

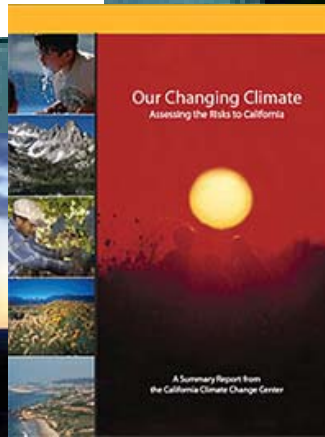
Up to four times as many heat wave days



Excess Mortality



Electricity Consumption





California Wildfires

55% increase in risk, 2070-2099?

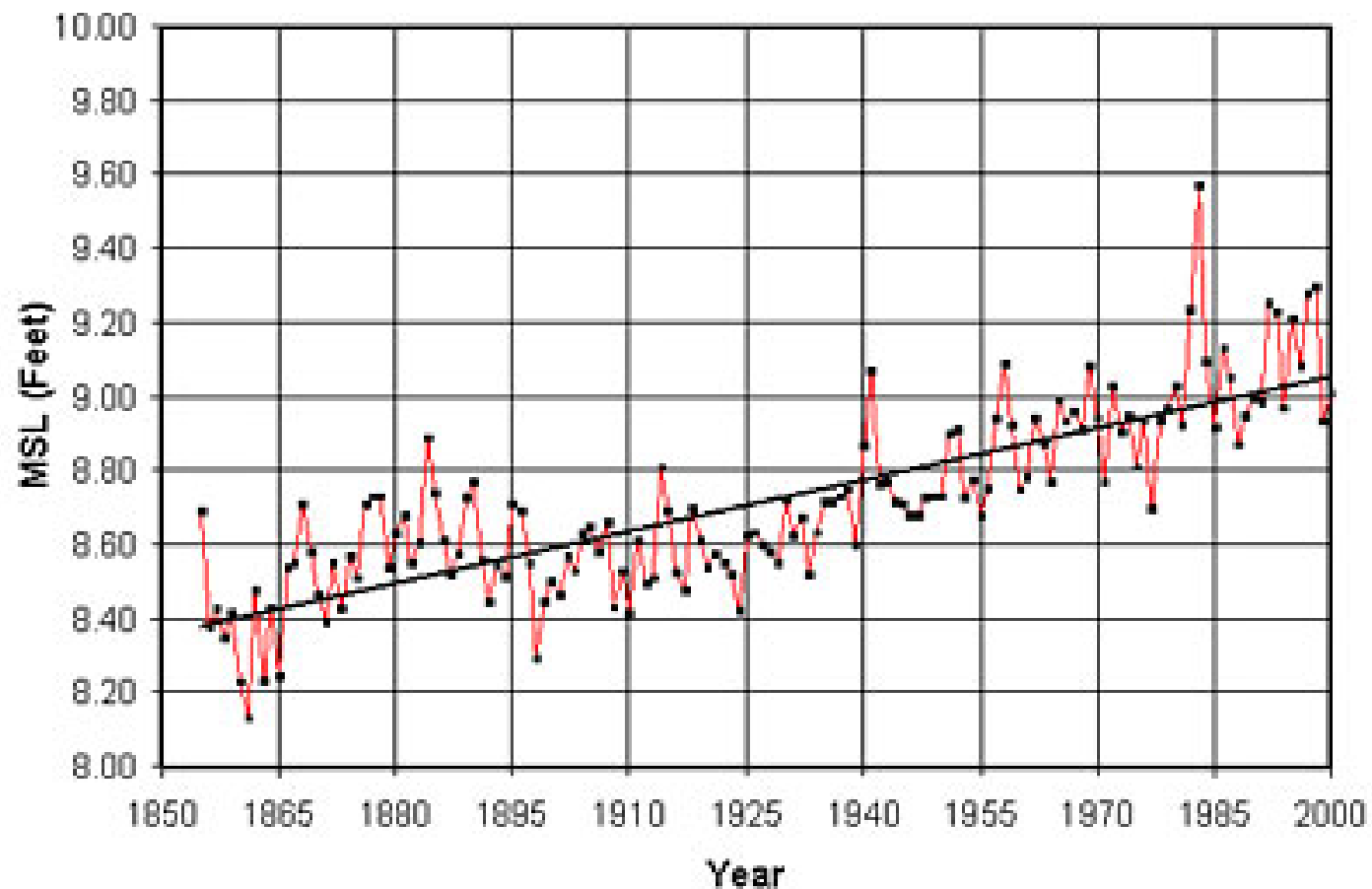
October 27, 2003





Rising Sea Level

6-30 inches, 2070-2099 *How much, how fast?*



One meter of
sea level rise

SFO



*Courtesy of
San Francisco Bay
Conservation and
Development
Commission*

December 20, 2005

January 4, 2006

Infrastructure

When to invest?

Engineering lifetime?

Flood insurance rates?

Land use policies?



Sacramento Delta

MODIS-Aqua



Economic Impact Assessments

Effective when forecast and investment timescales are similar

Require high spatial specificity

**WELLS
FARGO**

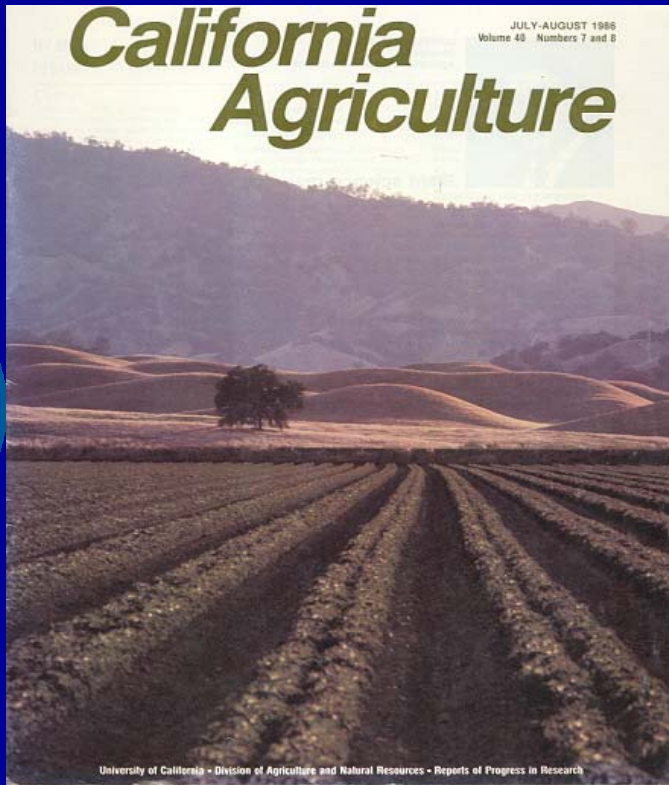


**Venture
Capital &
Angel Financing**



Decision Support

Agriculture and fisheries stakeholder outreach



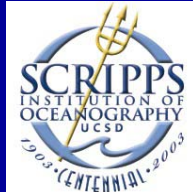
California Agricultural Extension

Climate change, fresh water,
food-biofuel competition



California Cooperative Fisheries Investigation

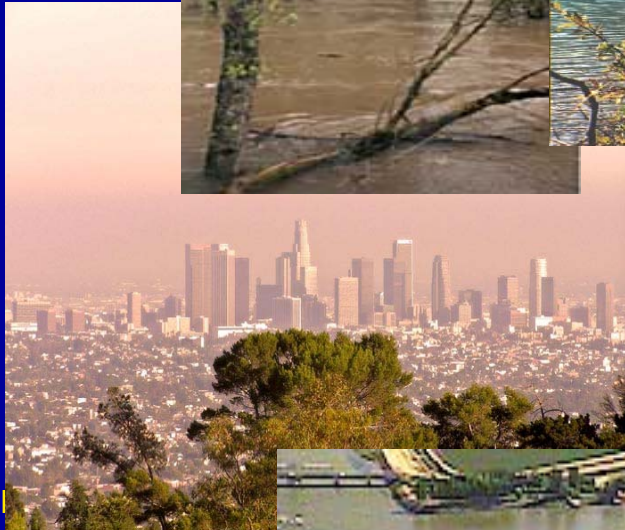
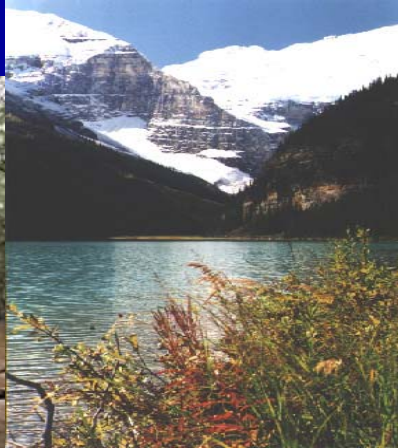
Warming Waters Identified as Cause of
Marine Life Depletions off California



Local Environmental Decision Support

Complex information enabling adaptive management

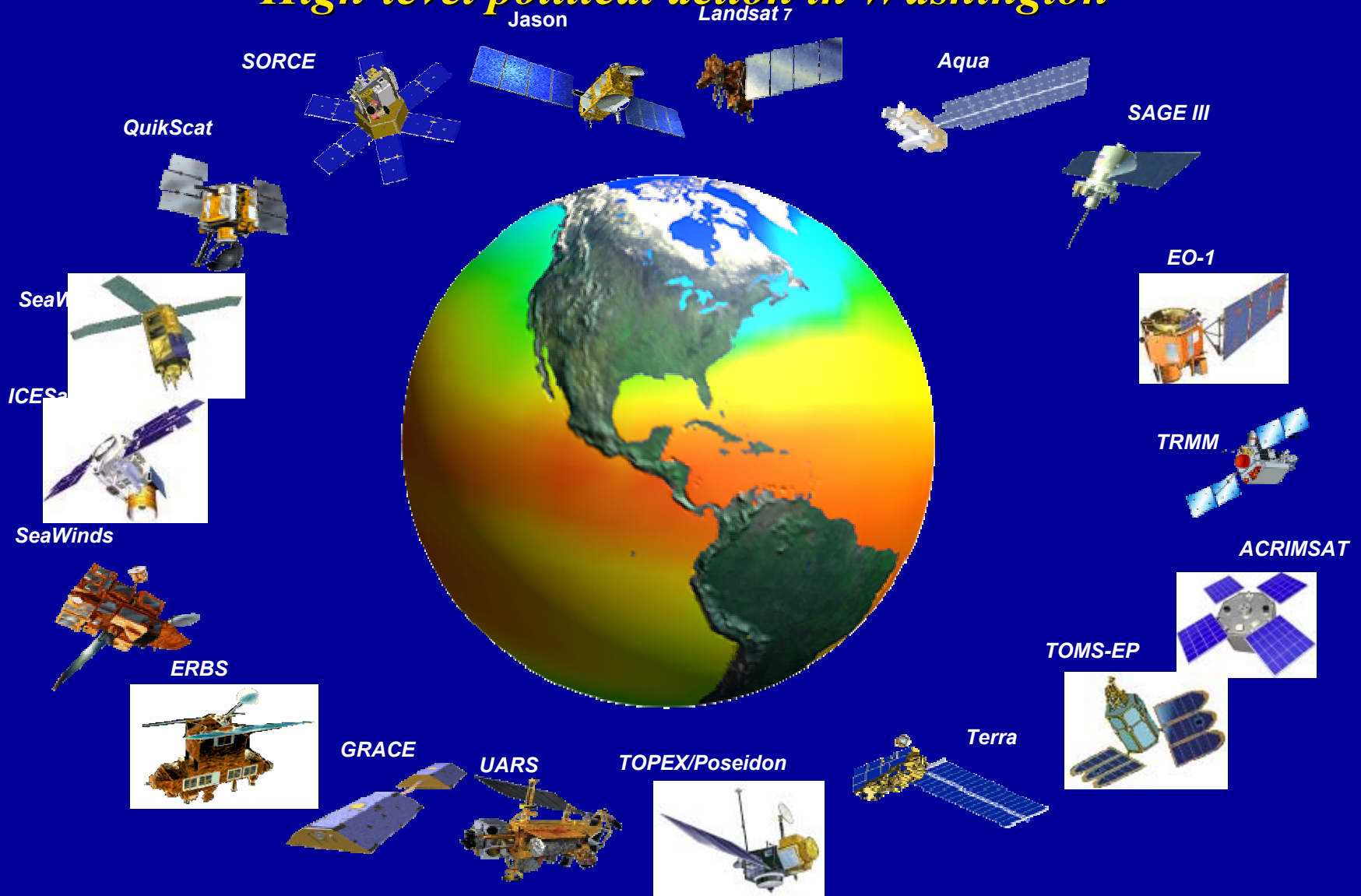
Needs local specialization and interactive communication



*Urban and
natural
environment
and ecology*

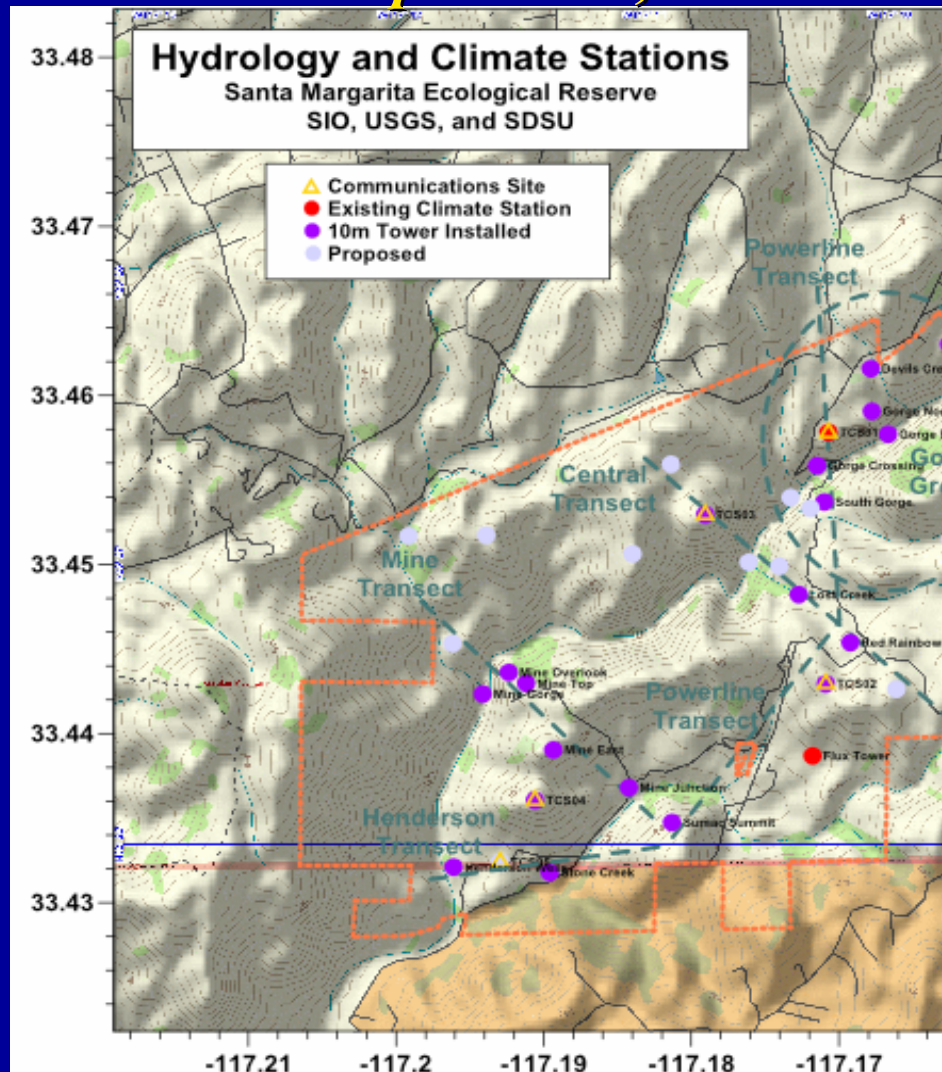
Ensure needed space observations

High-level political action in Washington



Deploy Regional Sensor-nets

Increase precision, enable adaptive management

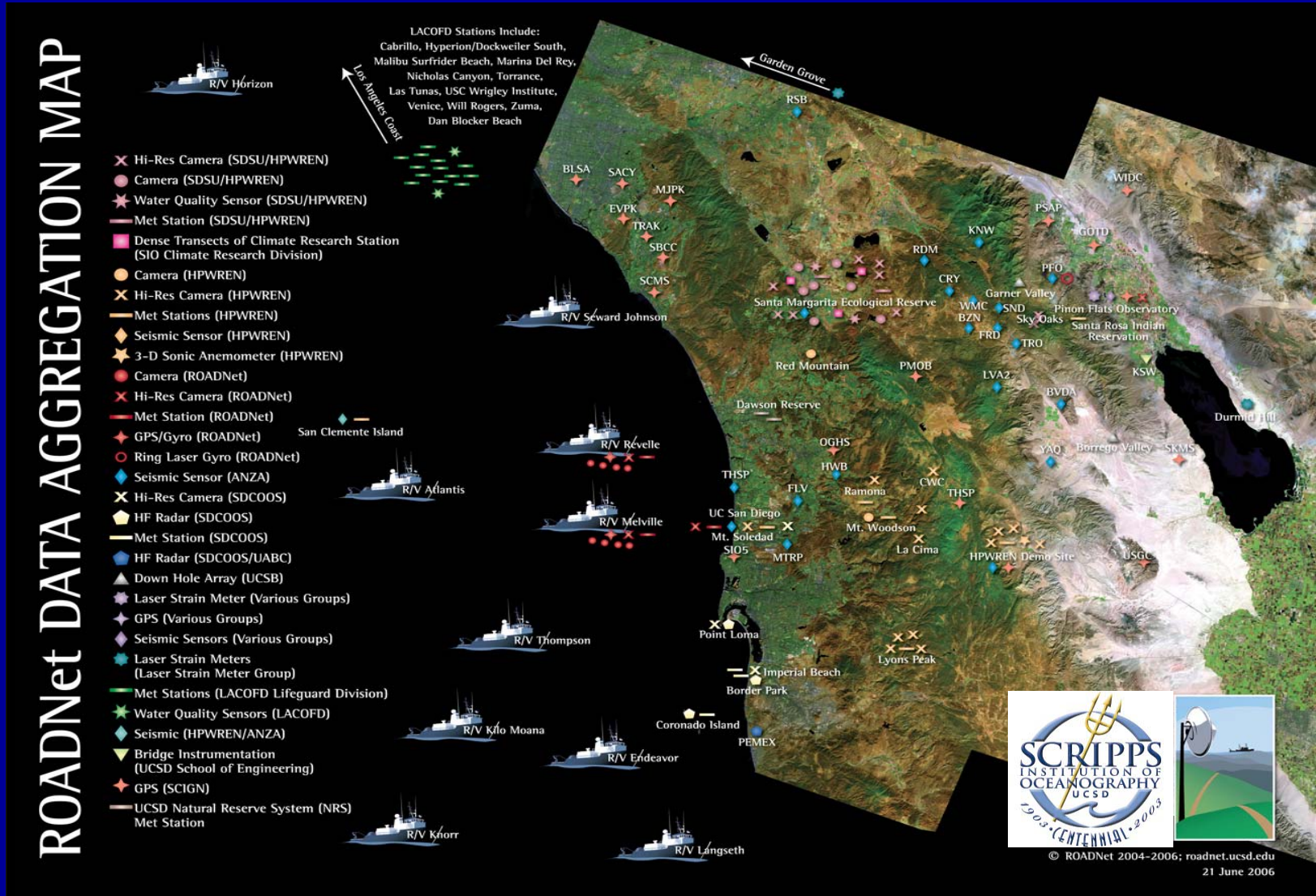


Water and Climate Instruments in the Santa Margarita Ecological Reserve
Source, Dan Cayan, UCSD SIO

Enhance environmental informatics capacity

Connect research institutions, integrate research and civil sensor nets

Communicate with stakeholders



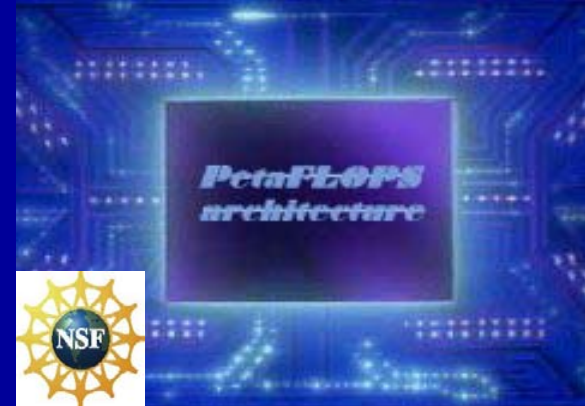
Climate Change Modeling

Link global models to local models and data

California, Federal agencies support cooperative programs



San Diego-15 Tflops



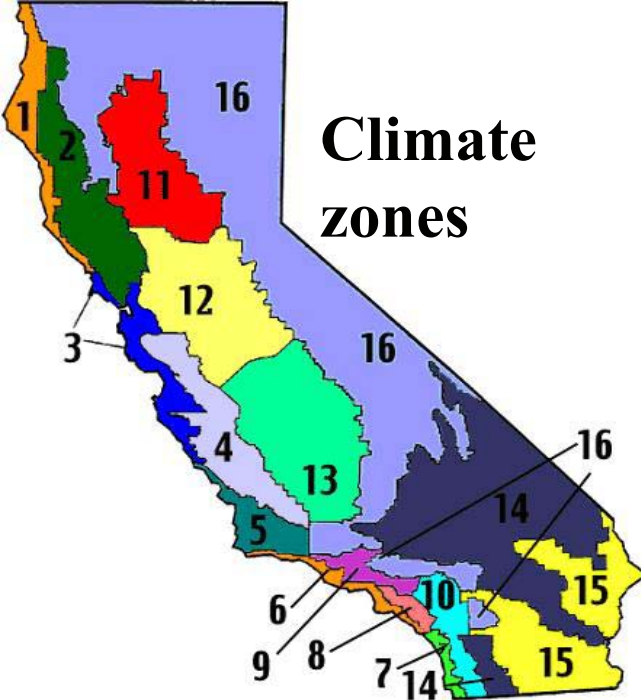
NSF Next Machine-PetaFlops



Columbia-60 Tflops

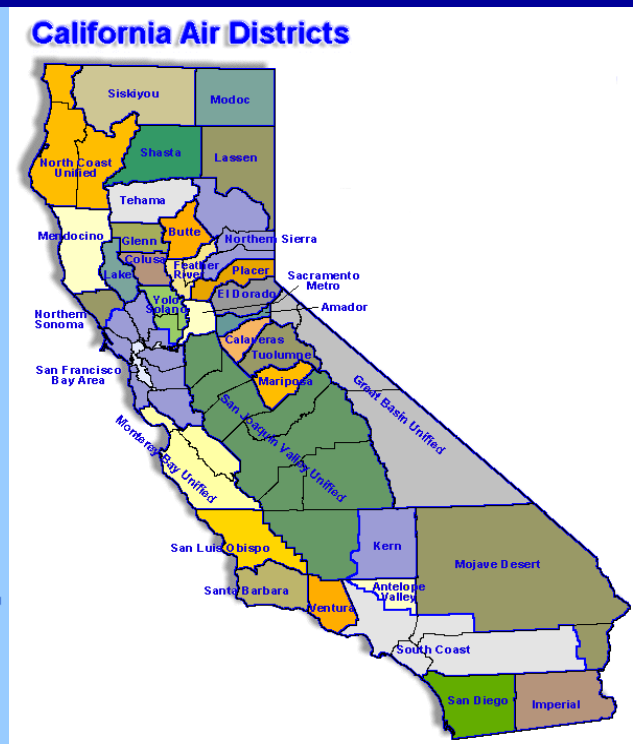


LLNL- >100 Tflops



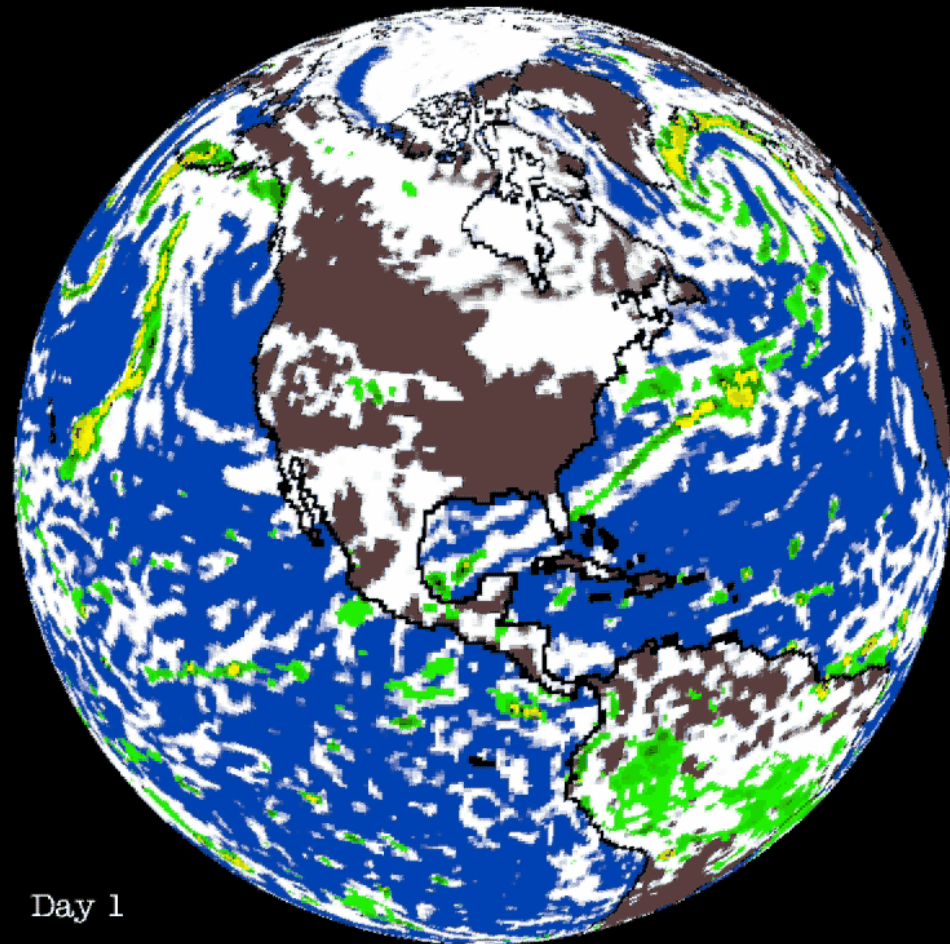
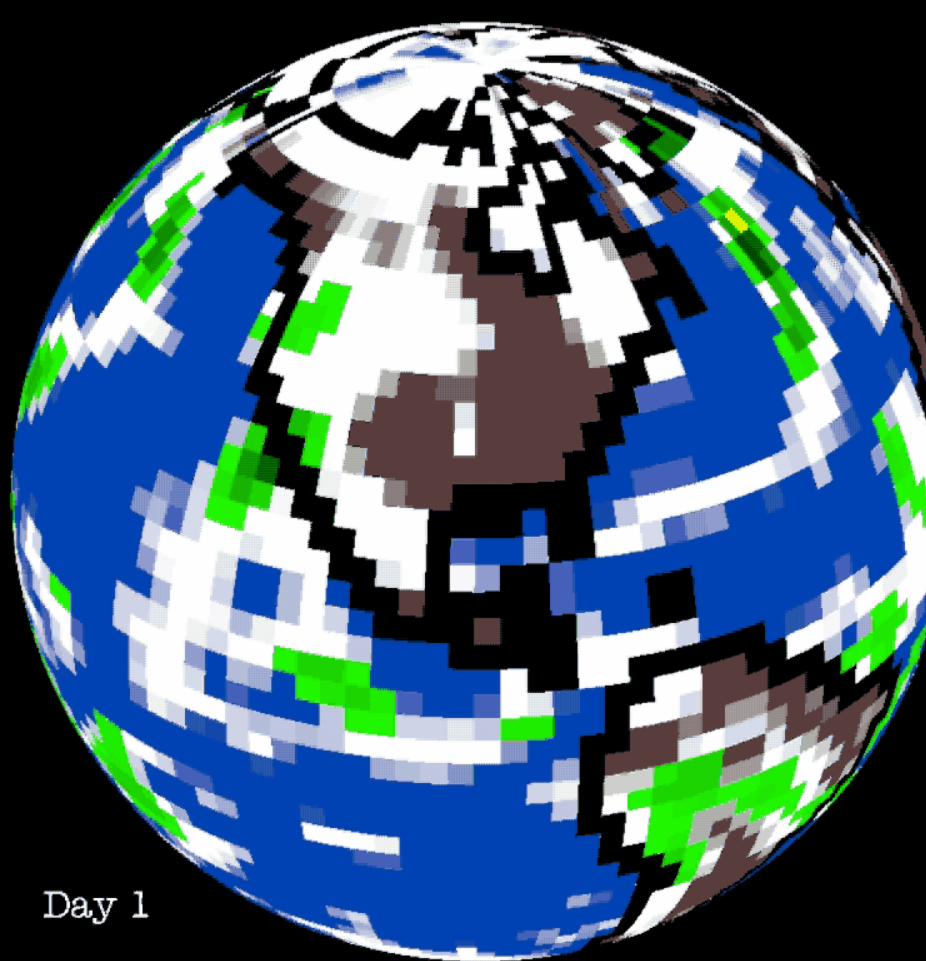
California Climate Regions

- *California-specific climate drivers,*
– *natural and human*
- *Regions not resolved by today's global models*
- *Californians understand their own concerns*

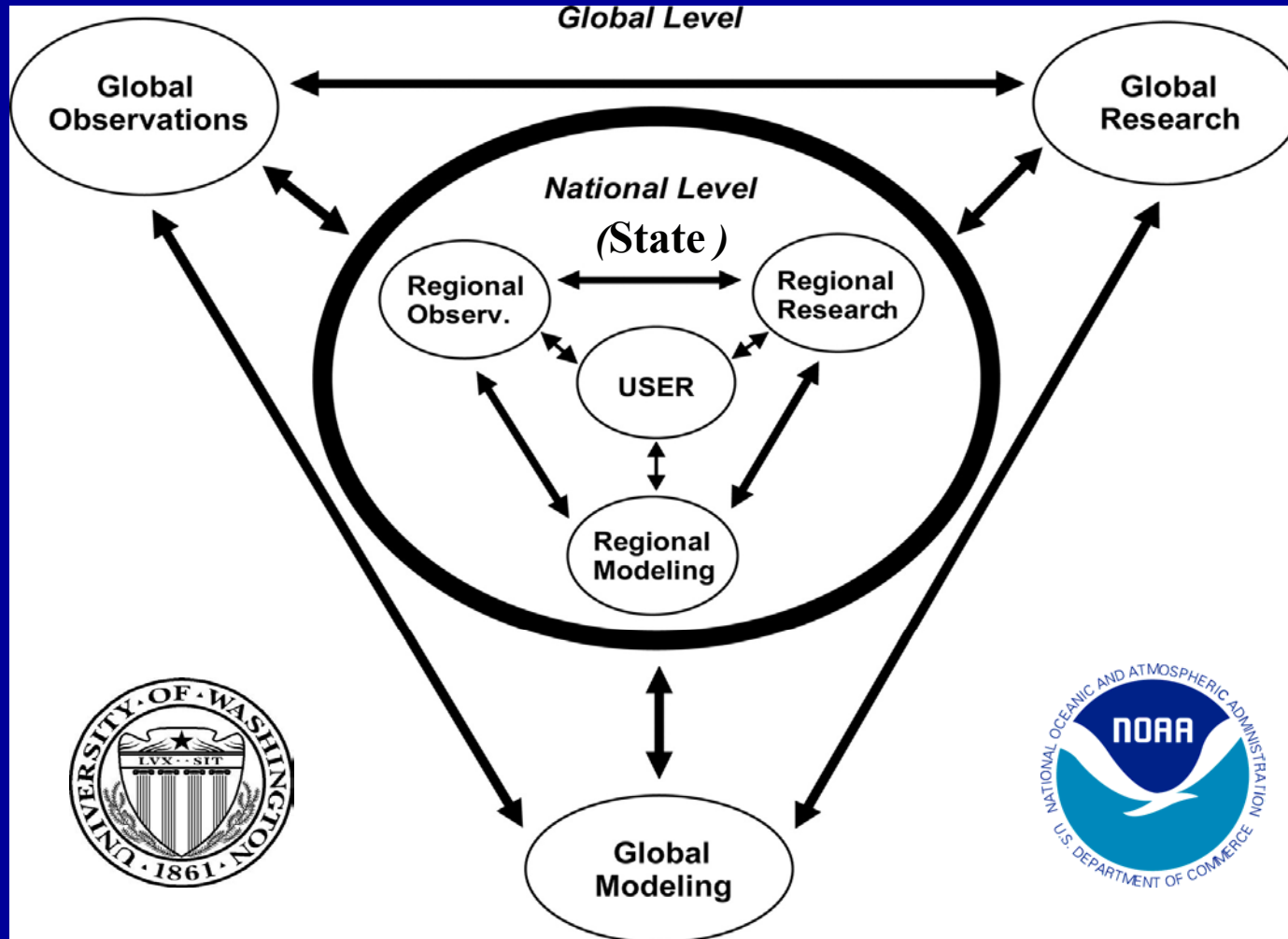


High resolution climate modeling allows
climate impacts to be predicted

High resolution climate modeling
allows climate impacts to be
predicted



Relationships between global and regional assessments



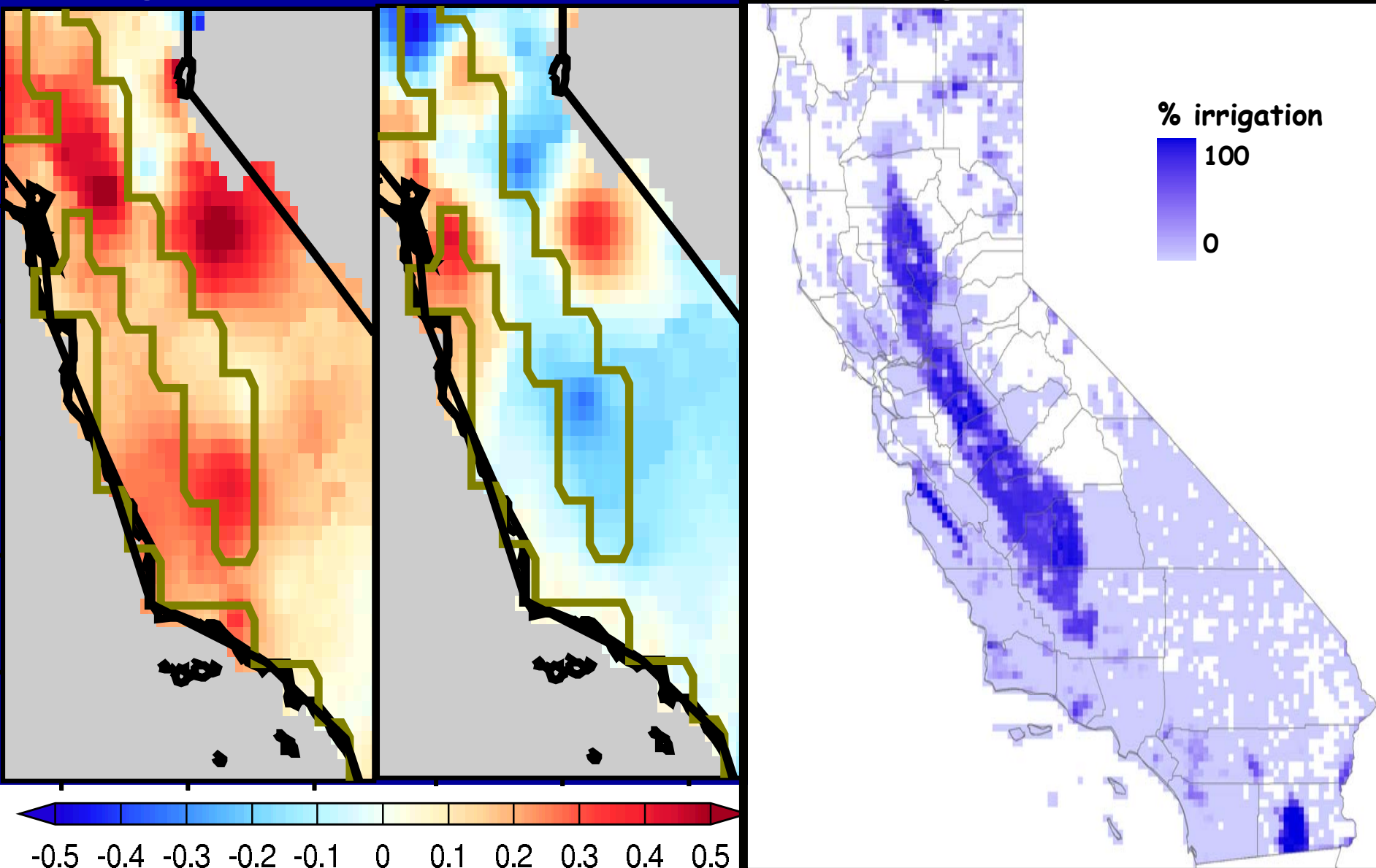
Miles, E. L. et al. (2006) Proc. Natl. Acad. Sci. USA 103, 19616-19623

Summer Temperature Trends 1915-1980 ($^{\circ}\text{C}/\text{decade}$)

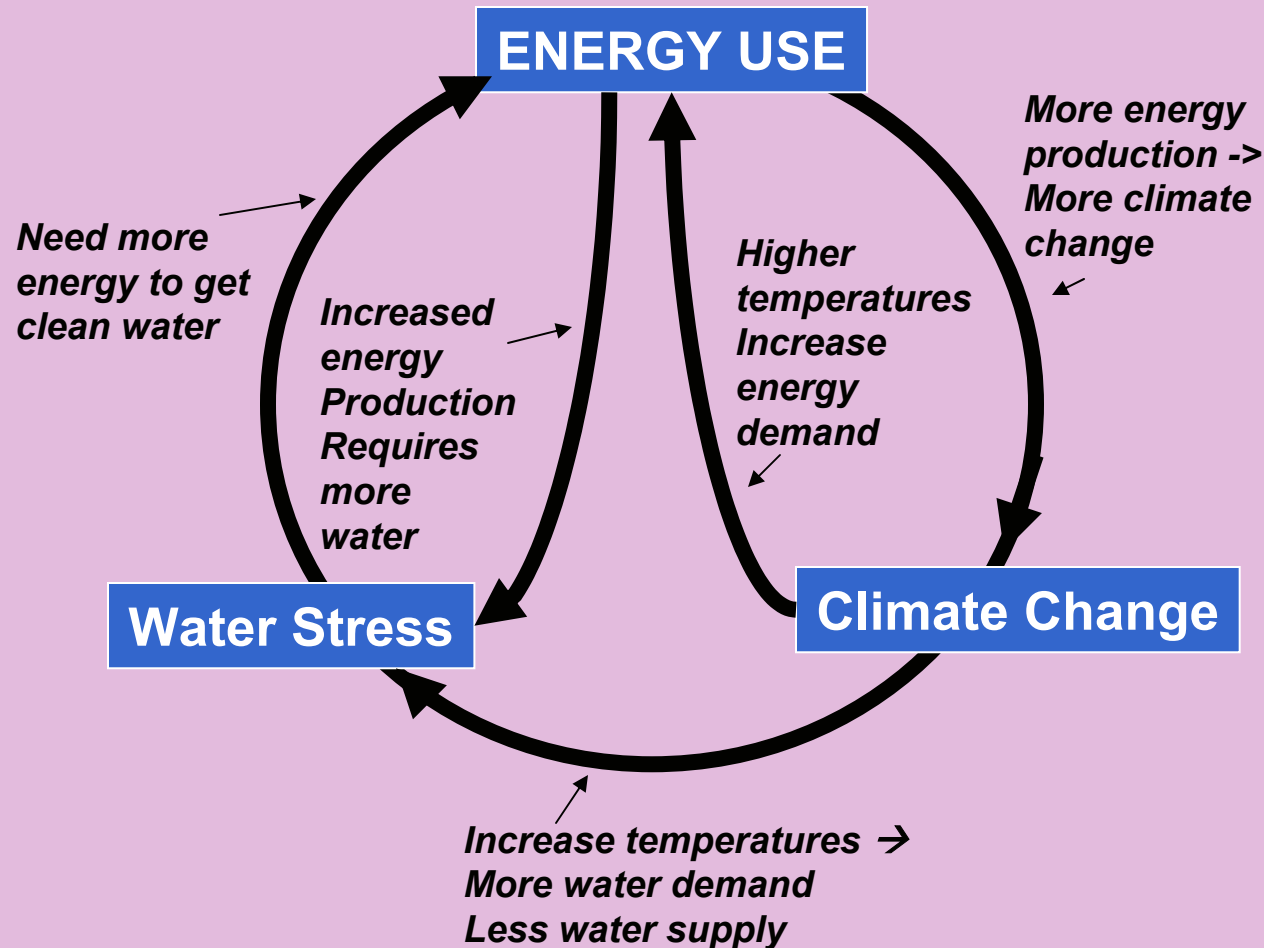
Night

Day

Irrigation



Self-reinforcing climate/water/energy cycle



Integrate climate and economic assessments

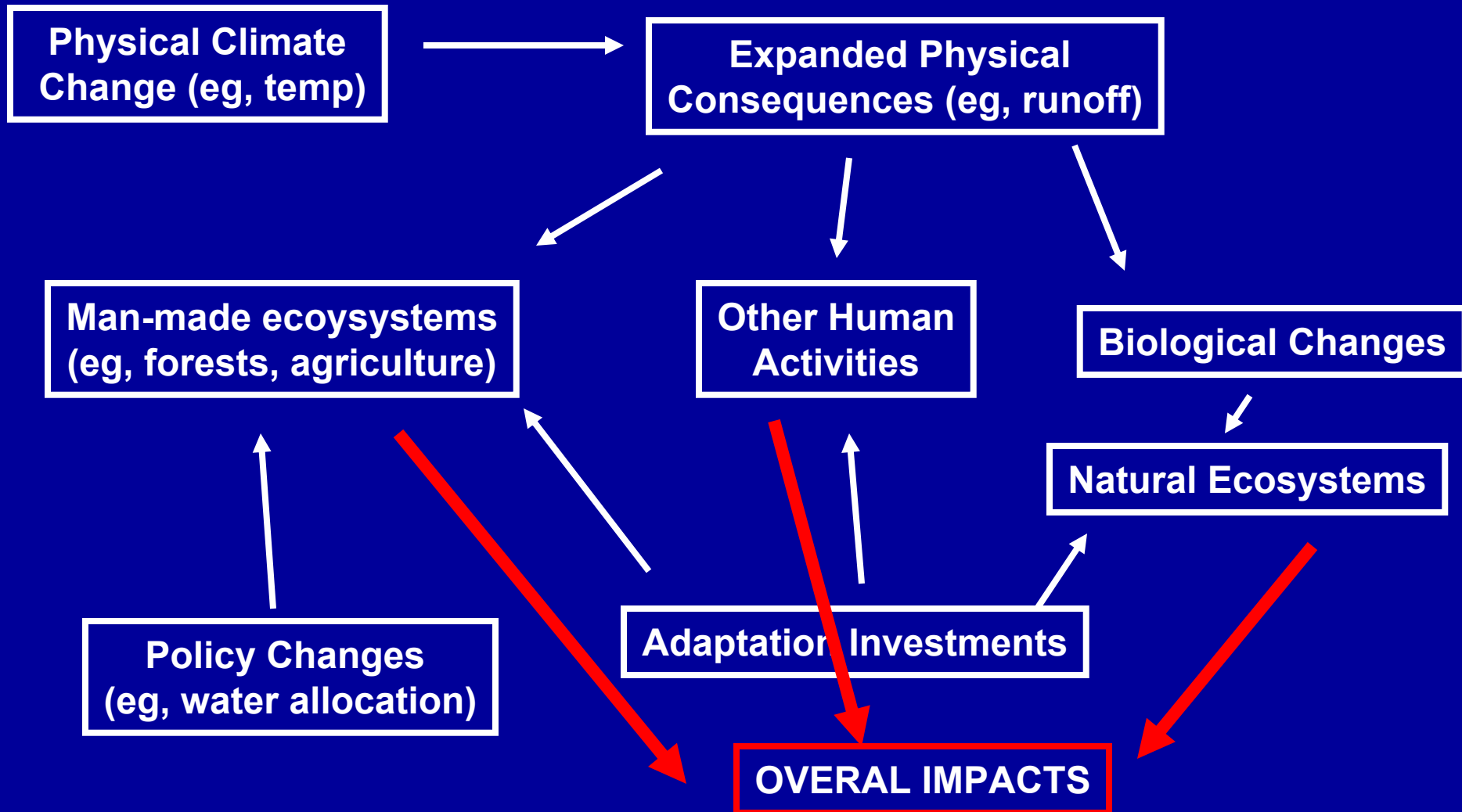
The next frontier



- **Specific, quantitative collaborations**
- **Involve decision-makers, stakeholders,**
- **Engineer decisions, not systems**
- **Work with communicators**

The (Messy) Causal Chain

Need info on all these links



Potential Climate Change Impacts

Individual well-being



Climate Changes

(means, variances, extremes)



Temperature



Precipitation

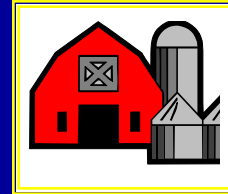


Sea Level Rise



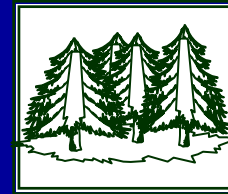
Health

Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Agriculture

Crop yields
Irrigation demands
Pest outbreaks



Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity
Pest outbreaks



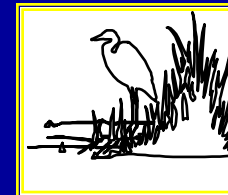
Water Resources

Changes in water supply
Water quality
Increased competition for water



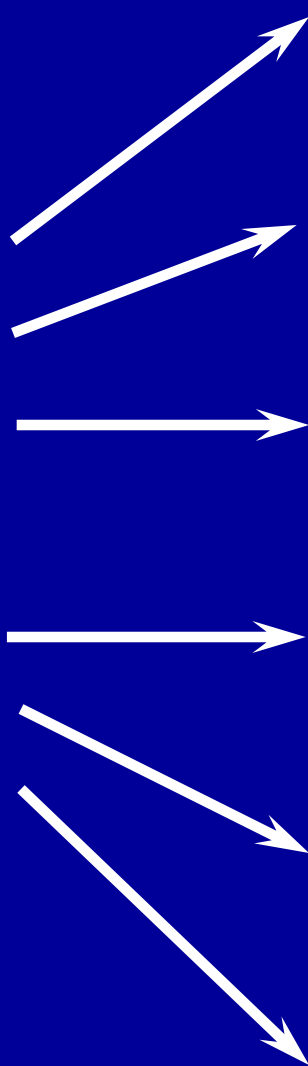
Coastal Areas

Erosion of beaches
Inundation of coastal lands
Costs to protect coastal communities



Species & Natural Areas

Shift in ecological zones
Loss of habitat and species



Adapted from EPA

Different paths to sectoral impacts

Health

Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



**Need information on diseases, vectors,
Weather extremes and susceptibilities.**

Different paths to sectoral impacts

Health

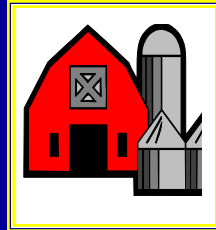
Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Need information on diseases, vectors,
Weather extremes and susceptibilities.

Agriculture

Crop yields
Irrigation demands
Pest outbreaks



**Need information on adaptation,
productivity, Crop choice, farm programs,
and water allocation.**

Different paths to sectoral impacts

Health

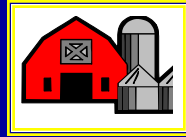
Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Need information on diseases, vectors,
Weather extremes and susceptibilities.

Agriculture

Crop yields
Irrigation demands
Pest outbreaks



Need information on adaptation, productivity,
Crop choice, farm programs, and water
Allocation.

Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity
Pest outbreaks



**Need knowledge of productivity changes,
Disease and harvesting changes.**

Different paths to sectoral impacts

Health

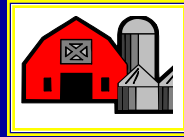
Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Need information on diseases, vectors,
Weather extremes and susceptibilities.

Agriculture

Crop yields
Irrigation demands
Pest outbreaks



Need information on adaptation, productivity,
Crop choice, farm programs, and water
Allocation.

Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity
Pest outbreaks



Need knowledge of productivity changes,
Disease and harvesting changes.

Water Resources

Changes in water supply
Water quality
Increased competition for water



How will water supply change? Allocation
Policies (eg ag vs. urban)? Demand and
Increased prices?

Different paths to sectoral impacts

Health

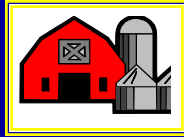
Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Need information on diseases, vectors,
Weather extremes and susceptibilities.

Agriculture

Crop yields
Irrigation demands
Pest outbreaks



Need information on adaptation, productivity,
Crop choice, farm programs, and water
Allocation.

Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity
Pest outbreaks



Need knowledge of productivity changes,
Disease and harvesting changes.

Water Resources

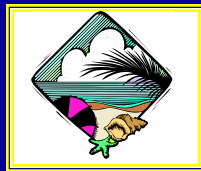
Changes in water supply
Water quality
Increased competition for water



How will water supply change? Allocation
Policies (eg ag vs. urban)? Demand and
Increased prices?

Coastal Areas

Erosion of beaches
Inundation of coastal lands
Costs to protect coastal communities



What protective measures are possible,
What is the rate of change? How do
Storm surges change?
What capital is at risk?

Different paths to sectoral impacts

Health

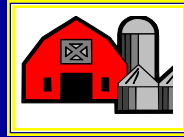
Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Need information on diseases, vectors,
Weather extremes and susceptibilities.

Agriculture

Crop yields
Irrigation demands
Pest outbreaks



Need information on adaptation, productivity,
Crop choice, farm programs, and water
Allocation.

Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity
Pest outbreaks



Need knowledge of productivity changes,
Disease and harvesting changes.

Water Resources

Changes in water supply
Water quality
Increased competition for water



How will water supply change? Allocation
Policies (eg ag vs. urban)? Demand and
Increased prices?

Coastal Areas

Erosion of beaches
Inundation of coastal lands
Costs to protect coastal communities



What protective measures are possible,
What is the rate of change? How do storm
Surges change? What capital is at risk?

Species & Natural Areas

Shift in ecological zones
Loss of habitat and species

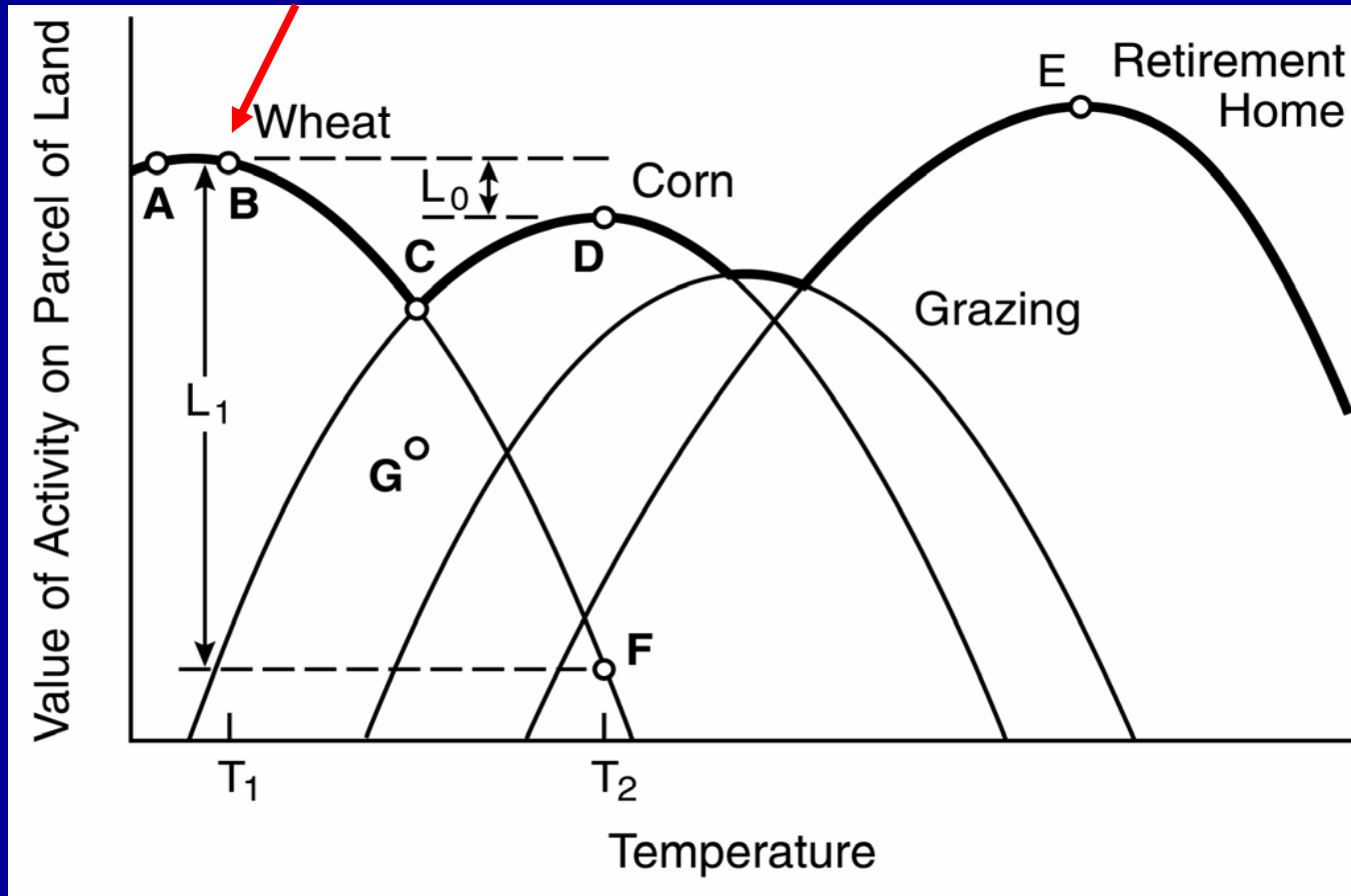


What are the ecological consequences?
How do those translate to habitat require?
What are implications for people?

A somewhat non-Californian example

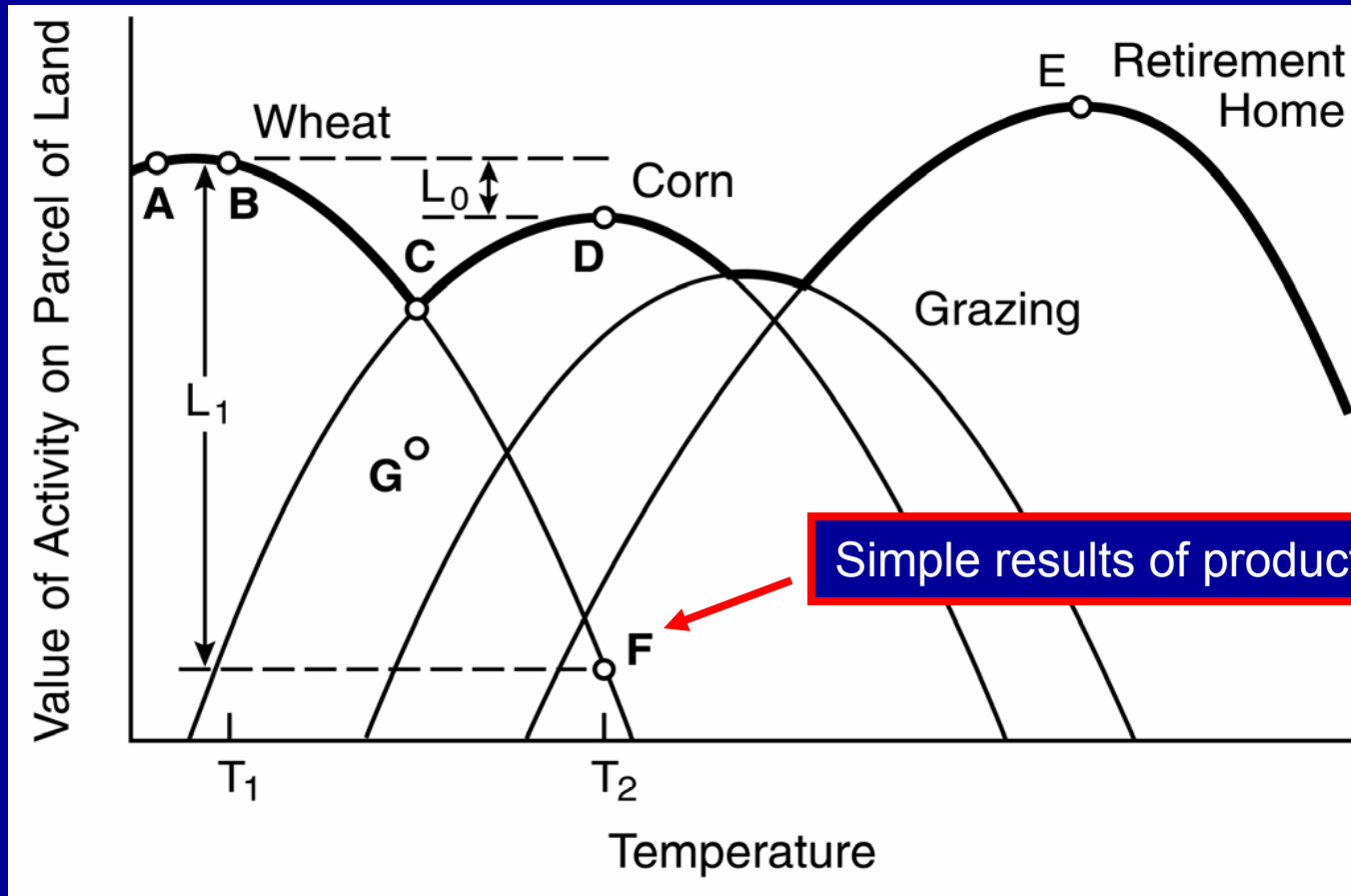
Some random acre in the Central Valley

Prior to climate change



A somewhat non-Californian example

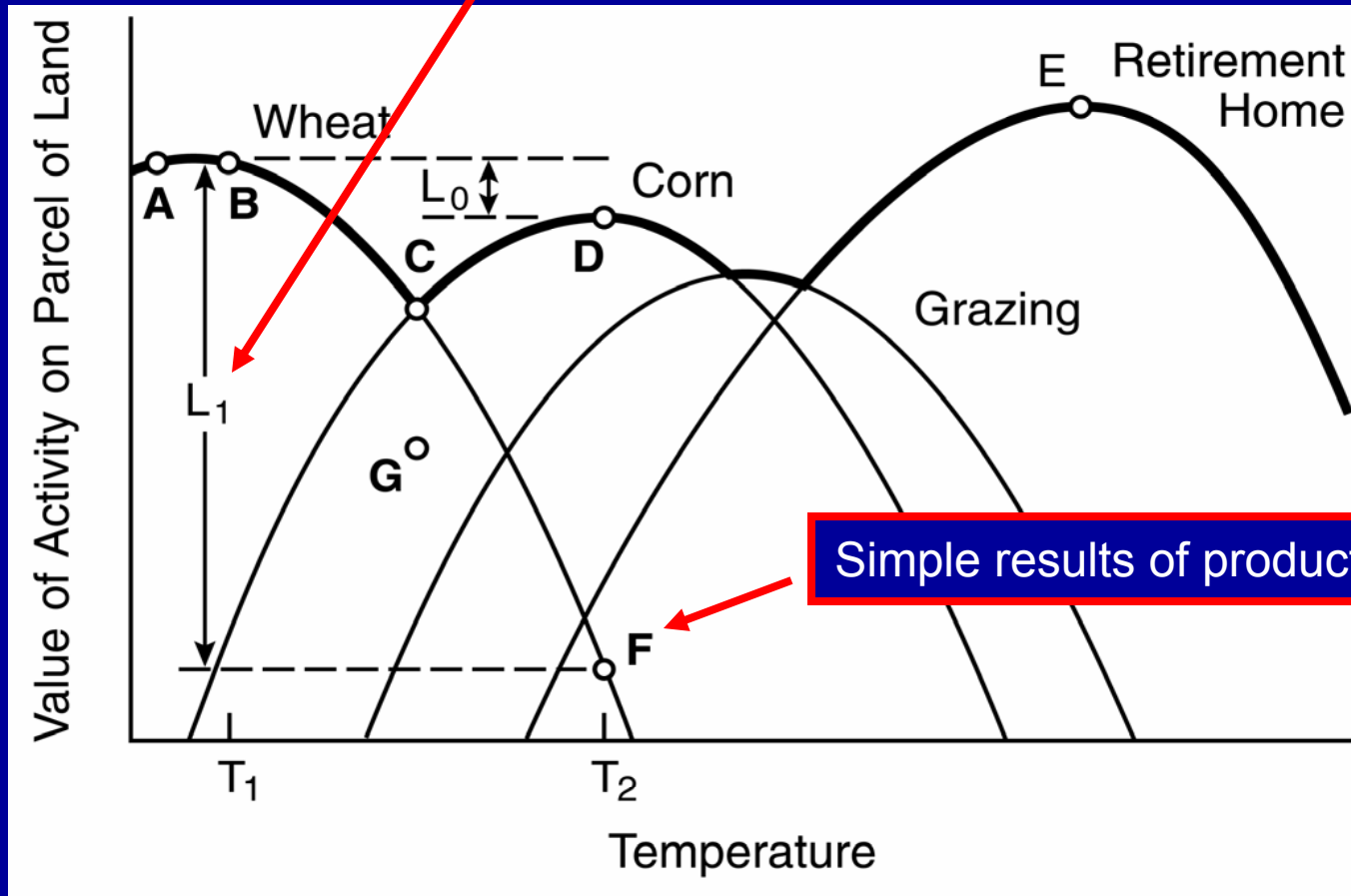
Some random acre in the Central Valley



A somewhat non-Californian example

Some random acre in the Central Valley

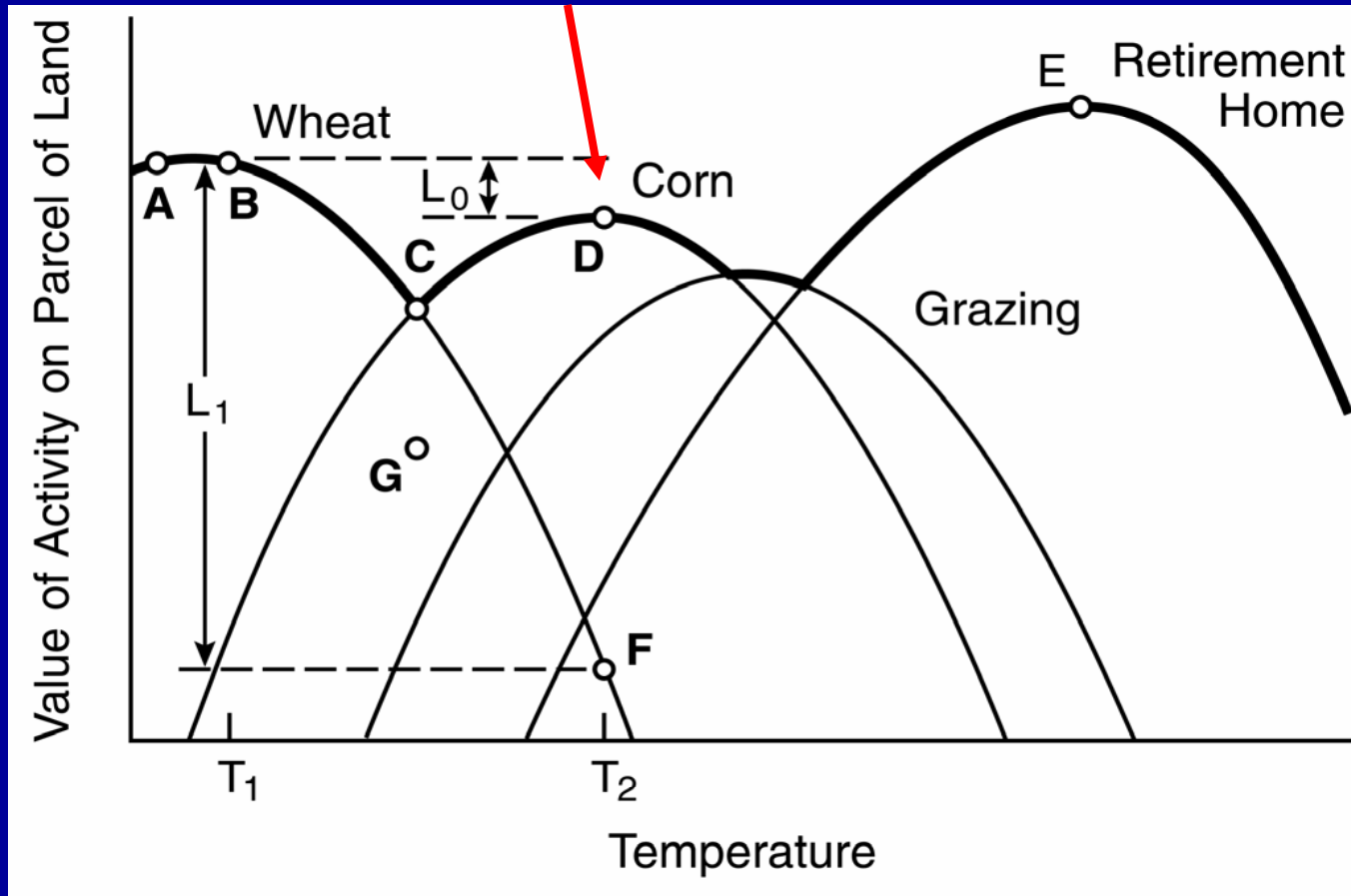
Loss from productivity analysis



A somewhat non-Californian example

Some random acre in the Central Valley

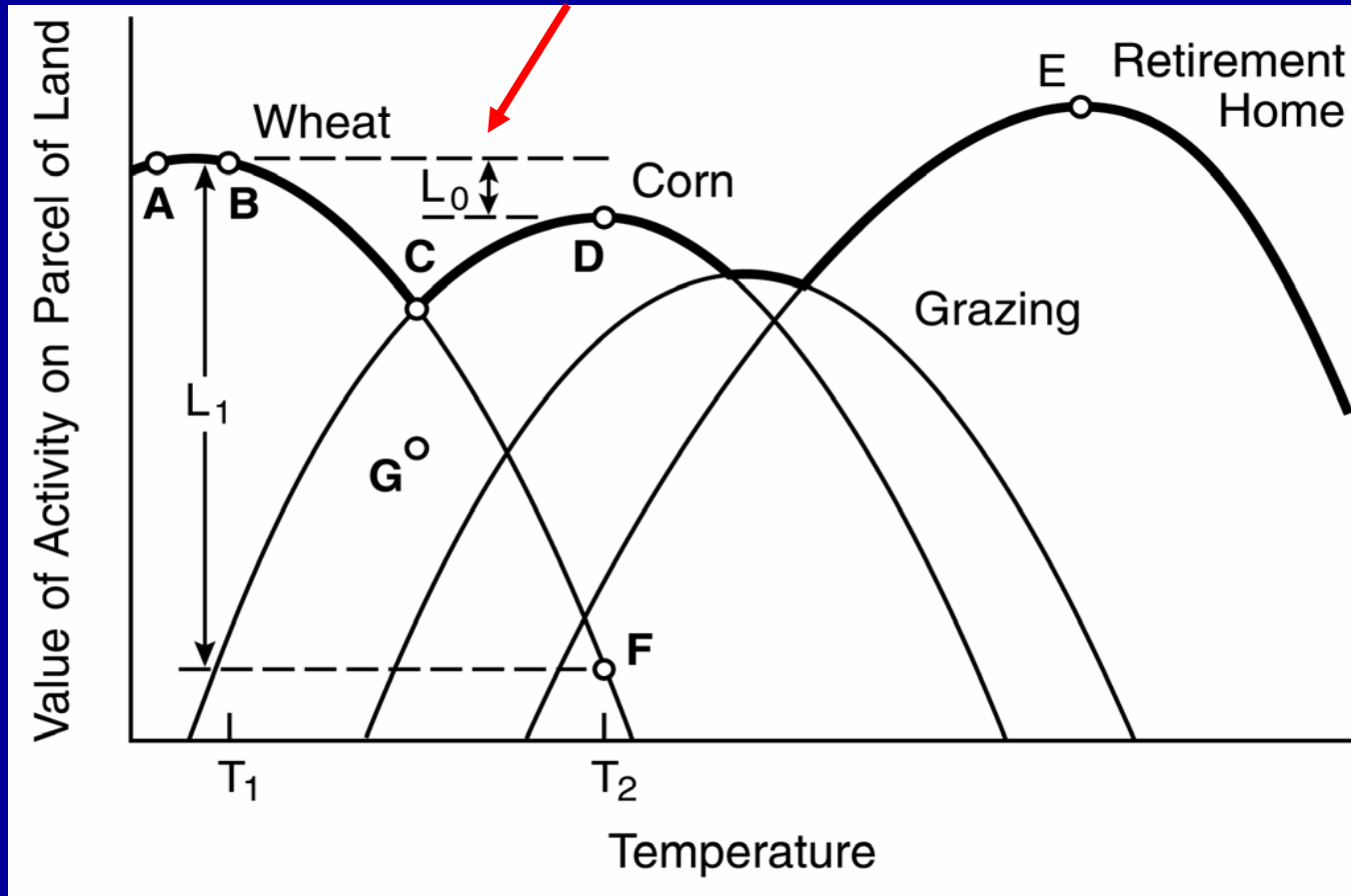
Result with crop change



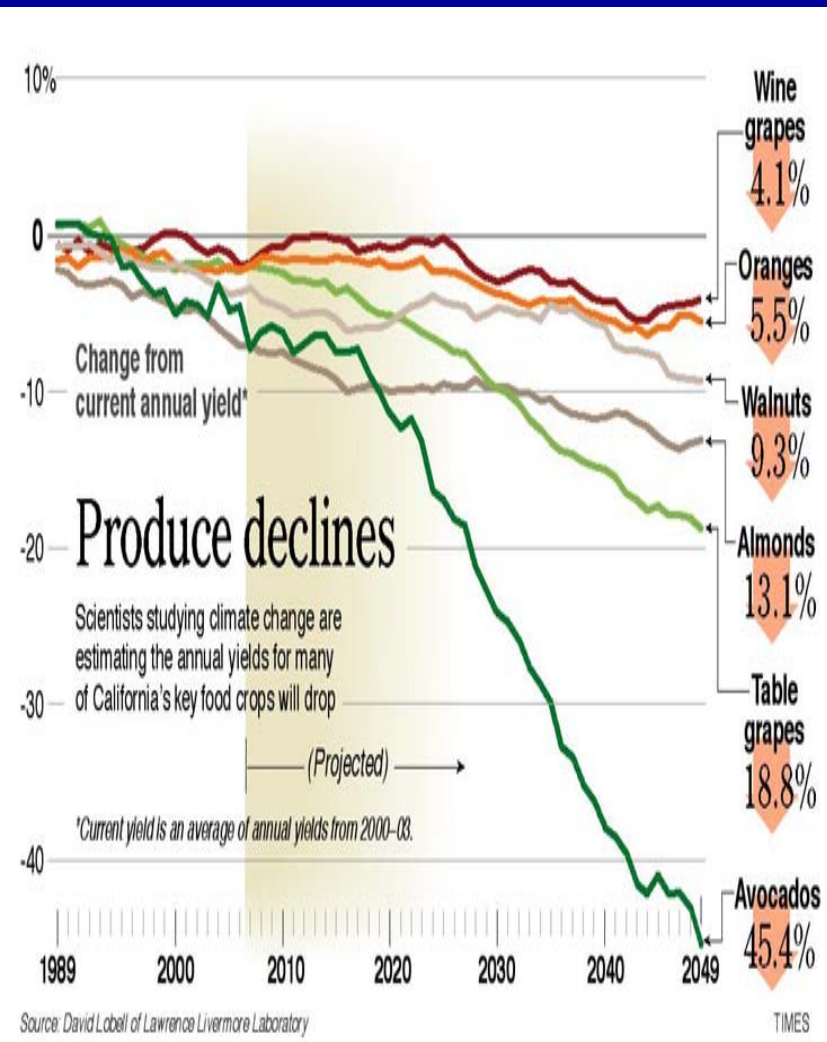
A somewhat non-Californian example

Some random acre in the Central Valley

Loss with crop change



For example....



Offsetting

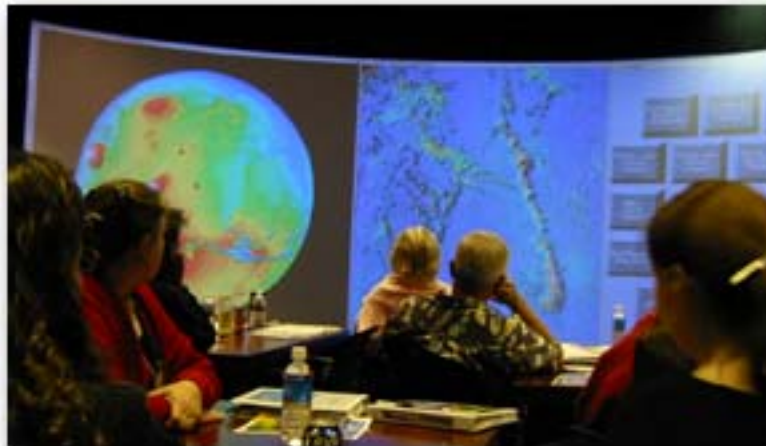
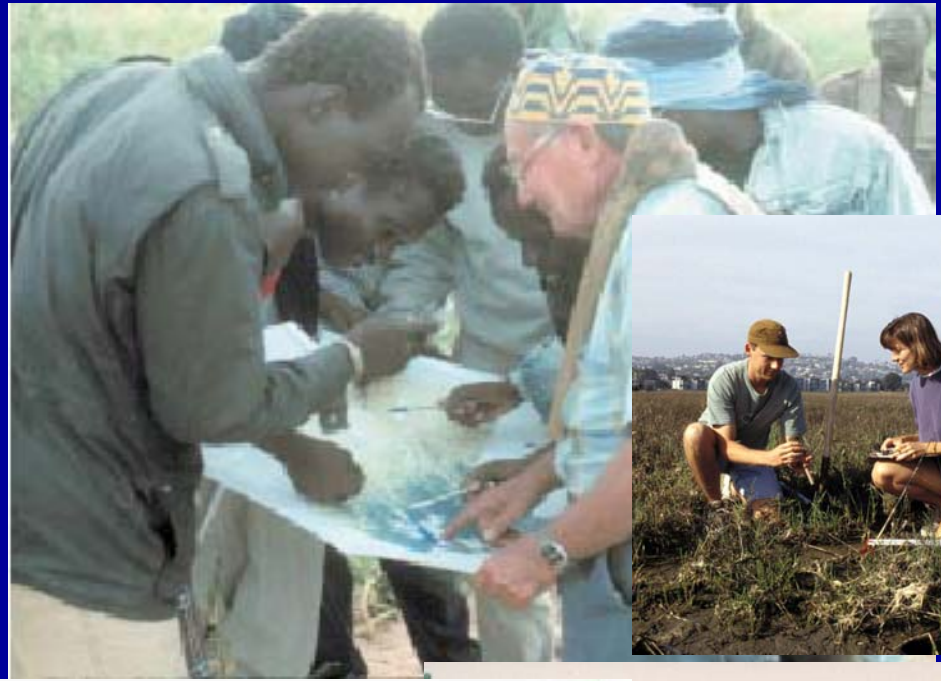
- crops move to different parts of CA
- crops move to different micro-climates (grapes)
- Varieties change
- Crops change
- UCDavis fixes problem
- Prices increase

Reinforcing

- Water moved to urban users
- Pests increase
- Risk increases
- Change unobserved

Assess, then assist

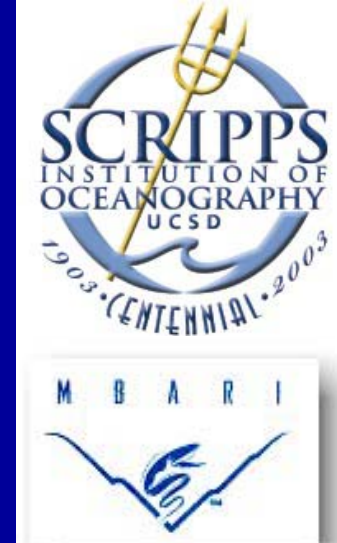
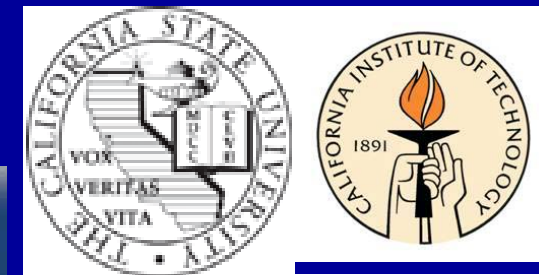
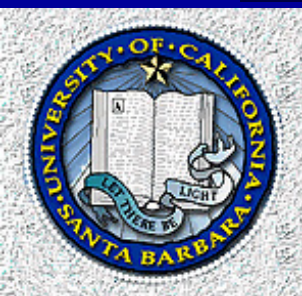
Earth observations,
predictive models,
and impact
assessments are
foundations of
decision support
systems and
services.



“What will happen to *me*?”

The most important question in environmental science





No other state has California's capability

•Commit to ongoing Climate Change Impact Assessments

- Independent governance and funding, defined schedule**
- Build on present success**

•Act to strengthen California's technical capacity

- Start strategic planning now**
 - Information systems, sensor-nets, space observations, computations, economics**
 - Strategy to connect existing programs and assets**
- Integrate institutional contributions**
 - Draw upon universities, laboratories, NGO's, and industry**
- Work with federal government**
 - Advocacy with Congress and administration**
 - Programmatic collaborations with federal agencies**

•Define management responsibility and funding authority

- Within State government**
- Governance of institutional network(s)**